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Preventive Medical Care

Standards, Usage, and Efficacy

Lee A. Lillard, Willard G. Manning, Christine E. Peterson,
Nicole Lurie, George A. Goldberg, Charles E. Phelps

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PREFACE

This report examines the use of preventive services in a general population, and the effects of such use on health status. The work draws on data from the RAND Health Insurance Experiment, a large-scale, controlled experiment in health care financing. For a discussion of HIE findings, see J. P. Newhouse, "A Design for a Health Insurance Experiment," *Inquiry*, Vol. 11, 1974, and Robert H. Brook et al., *The Effect of Coinsurance on the Health of Adults*, R-3055-HHS, December 1984.

The research reported here was performed under a grant from the Health Care Financing Administration, U.S. Department of Health and Human Services.

SUMMARY

Although the literature contains studies of particular populations (e.g., poor children), this study is one of the few examinations of preventive medical care in a general population. It addresses two principal questions: Are Americans taking advantage of preventive-care services to the extent recommended by physicians? How effective is preventive care in reducing health expenditures and improving health status?

To answer these questions, we analyze data collected in the Rand Health Insurance Experiment (HIE). The HIE data enable us to overcome some of the limitations of prior studies. The data are based on a representative sample that is demographically similar to the general population of six urban and rural sites from the four census regions of the United States. The HIE included a randomly assigned preventive health measure: A total of 60 percent of HIE participants were randomly selected to receive a general physical examination upon entry to the study. All participants were randomly assigned to one of several insurance plans with varying levels of coinsurance (out-of-pocket payments). The varying insurance coverage allows us to test for the relative effects of cost-sharing on use of preventive and other outpatient care. Random assignment of insurance plans, and the physical examination, guarantee that those results are not affected by adverse selection--e.g., by the tendency of the sickly to acquire better health insurance and seek more preventive and nonpreventive care.

EFFECTS ON USE OF HEALTH SERVICES AND HEALTH STATUS

We found a small beneficial, but statistically insignificant, effect of a randomly assigned physical examination upon the use of health services and upon the individual's health status after three years. Averaged over the three-year period, those who received the entry physical examination spent $17 per person per year less than those who did not ($t = -0.40$). Those who received the entry examination had insignificantly higher health status (0.26 units, $t = 0.45$); that amount

insignificantly higher health status (0.26 units, t = 0.45); that amount is roughly equivalent to 5 percent of the difference in health status associated with having hypertension. When we examined the effects of preventive care sought by individuals during the course of this study, we found the same pattern of statistically insignificant, small, beneficial effects upon health status.

Thus, it appears that *adding* a small amount of preventive care at present levels of preventive use does not have any appreciable effect. This is not a judgment about the value of all preventive care, as a take-it-or-leave-it proposition. The benefits of all preventive care are quite impressive.

FREQUENCY OF PREVENTIVE USE

We found that many people, especially adult males, are not getting the recommended levels of preventive care. Over the three years of the study, only one fourth of the men had any use of preventive services. Two thirds of the women received the recommended Pap smears, but few received mammograms. Most children appeared to receive some of their needed immunizations eventually, but not on schedule. Less than half of the children 18 months and younger received the recommended polio and DPT (diphtheria-pertussis-tetanus vaccines). There was some tendency to wait until children had to have the immunizations for enrollment in school.

How much more would it cost than we are now spending to ensure that each person got the recommended levels of well care? We estimated that it would cost about $10 per man to bring men up to a level of at least one well-care visit (with a rectal examination) in three years. It would also cost nearly $10 per woman to bring women up to a standard of at least one well-care visit with a Pap smear in three years, and $116 per woman aged 45 to 65 if a mammogram were included in the three-year standard. It would cost about $22 more per child than is now spent to ensure that every child had a full set of DPT and polio shots by age 18 months.

COST-SHARING AND THE USE OF PREVENTIVE SERVICES

Some people believe that cost-sharing for outpatient care, and particularly preventive care, is a major deterrent to people's receiving the preventive care that the medical profession recommends. Some even believe that free preventive care would pay for itself in future cost-savings. Our data show that preventive care does respond significantly to out-of-pocket costs, but is less responsive to cost-sharing than is nonpreventive care.

Although cost-sharing is an important determinant of the use of services, it is not the only obstacle to receiving the recommended levels of preventive care. When we looked at enrollees on the plan that required *no* out-of-pocket cost to the patient--a plan much more generous than those commonly available--we found that substantial fractions of the population were still not seeking or getting the well care that the medical profession recommends.

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We would like to thank our RAND colleagues Mark Chassin, Susan Marquis, and Albert Williams for helpful suggestions and comments on the economic aspects of this report; and the past and present project officers for the Health Insurance Experiment, Larry Orr and James Schuttinga, for their support of the Health Insurance Experiment data collection. We appreciate the advice and support for this research provided by Benson Dutton of the Office of Research and Demonstration, Health Care Financing Administration.

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Part 1

GENERAL DISCUSSION OF THE HEALTH INSURANCE EXPERIMENT AND ITS RESULTS PERTAINING TO PREVENTIVE CARE

I. INTRODUCTION

How much preventive care are Americans getting? How much is desirable? Should preventive care receive special attention and recognition in public health insurance programs, or especially favorable tax treatment in private insurance (as the Congress debates how such tax treatment should be structured in the future). These and other questions about public-policy issues depend to a great extent on the efficacy of preventive care in achieving its goals.

The benefits of preventive care are truly impressive when viewed historically both in the United States and worldwide. Vaccination against contagious disease has eliminated much death and suffering. Large numbers of people point to early diagnosis of disease as critical to their current survival. That such prevention has proven of immense value cannot be disputed. The very success of past preventive activities makes it difficult to analyze the future desirability of *additional* preventive care, for we are now obliged to focus on its marginal effect rather than consider the average effect of all preventive activity undertaken in our society.

This study brings new data and analytic techniques to bear on two central questions: Are Americans taking advantage of preventive-care services to the extent recommended by physicians? How effective is additional preventive care in reducing health expenditures and improving health status? Although the literature contains studies of particular populations (e.g., poor children), this study is one of the few to examine preventive care in a general population.

First, we consider the extent to which certain subgroups of the population at risk for certain diseases are receiving recommended preventive measures. We examine the frequency of immunizations for children and adults, and of cancer screening for adults. We assess the likelihood of making a visit for well care. We also estimate what it would cost if persons who do not take advantage of preventive measures were to meet recommended standards for doing so.

Second, we assess the efficacy of the use of medical services by attempting to demonstrate associations between their use and health outcomes. We measure the use of preventive medical services by (1) a randomly assigned physical exam and (2) the frequency of visits for preventive services. Our health-outcome measures include the frequency and the costs of outpatient visits (both for all nonpreventive visits and for visits related to prevention and early detection), the frequency and costs of inpatient hospital admissions, and changes in health status.

Our analysis is based on data collected for Rand's Health Insurance Experiment (HIE). The HIE data enable us to overcome some of the limitations of prior studies. The data are based on a representative sample that is demographically similar to the general population. The sample consists of HIE enrollees at six urban and rural sites in the four census regions of the United States. The HIE included a randomly assigned preventive health measure. A total of 60 percent of the enrollees were randomly selected to receive a general physical examination upon entry into the experiment. The results were reported to the patients' physicians. Finally, all enrollees were randomly assigned to one of several insurance plans with varying levels of coinsurance (out-of-pocket payments). The intention of HIE researchers was to examine the effects of cost-sharing on health status and use of health care. In this study, the varying plans allow us to test for the relative effects of cost-sharing on use of preventive and other outpatient care. Random assignment of insurance plans, and the physical examination, guarantee that those results are not affected by adverse selection--e.g., by the tendency of the sickly to acquire better health insurance and seek more preventive and nonpreventive care, or by the sample's consisting solely of people who go to a physician for some preventive service.

We concentrate on the analysis of two of the *quantity* aspects of the valuation of preventive care: reductions in the amount of medical care (visits and costs), and observed changes in health status. We do not study elimination of pain and suffering or changes in mortality

brought about by preventive care. (Since the HIE sample does not include the aged, we would not have been able to measure medically significant changes in mortality.)

II. DATA AND RESEARCH METHODS

In this section, we briefly summarize the Health Insurance Experiment (HIE) data used in our analysis. We discuss our definitions of preventive care use, outpatient and inpatient use, cost computations, and the definitions of explanatory variables. Finally, we summarize the econometric approach we employ. This review is intended only as a general overview for the reader who is more interested in our results than in the methodology. For a fuller discussion of data and methods, see Sec. VI.

HEALTH INSURANCE EXPERIMENT

The HIE is a randomized trial for studying the effects of different health insurance policies on the demand for health services and the health status of individuals. The HIE enrolled families in six sites: Dayton, Ohio; Seattle, Washington; Fitchburg, Massachusetts; Franklin County, Massachusetts; Charleston, South Carolina; and Georgetown County, South Carolina. These sites cover the range of stress on the medical market, from sites with quick access to physicians to ones with long delays for appointments (see Newhouse et al., 1981, p. 6). This analysis uses data from the first four of these sites. (When we began this study, data from two of the sites were not available.)

In each site, families enrolled for either three or five years, and were assigned to one of 14 insurance plans. The plans had different levels of coinsurance (percentage paid out-of-pocket) up to an upper limit on out-of-pocket expenses of $1000 per family per year. Beyond that limit, all care was free for the remainder of the year. The plans are grouped into five basic categories for our analysis: free care, coinsurance rates of 25 percent, 50 percent, and 95 percent, and an Individual Deductible Plan (95 percent coinsurance for outpatient care with a maximum of $150 per person or $450 per family, and free inpatient care).

The HIE included three randomized subexperiments to test for methods effects. To increase precision in measuring changes in health status, 60 percent of enrollees were given a physical examination at the time of entry into the experiment. To measure sick-loss days and telephone calls, some households kept diary entries on contacts with the health care system. Finally, to test for transitory aspects of the study, some households were enrolled for three years, others for five.

Families were enrolled as a unit, with only eligible members participating. No choice of plan (or other experimental treatment) was offered; the family could either accept the experimental plan or choose not to participate. To minimize refusals, families were given a lump-sum payment equal to their worst-case financial risk associated with the plan; thus, no family was worse off financially for being in the study. The amount of the lump-sum payment was independent of health care services used. Thus, it should be considered a temporary change in income and should not affect the responses studied below.

Families were assigned to treatments using the Finite Selection Model (Morris, 1979). This model is designed to achieve as much balance across plans as possible while retaining randomization; that is, it reduces correlation of the experimental treatments with health, demographic, and economic covariates.

The HIE sample is a random sample of the general population at each site with the following exclusions (groups who were not eligible): (1) those 62 years of age and older when the experiment began; (2) those with incomes in excess of $25,000 in 1973 dollars (or $58,400 in 1984 dollars); (3) those eligible for the Medicare disability program; (4) those in jail or institutionalized in long-term hospitals; (5) those in the military or their dependents; and (6) those with military service-related disabilities. A total of 3974 individuals were ultimately enrolled in our four sites. Aside from the above-mentioned exclusions, the HIE enrolled sample was representative of the population at large, except that children were slightly overrepresented (see Morris, 1985). Because we control for age, however, that does not pose a problem.

PREVENTIVE-CARE ANALYSIS POPULATION

The sample used for the preventive-care analysis consists of a subset of HIE enrollees who participated during the entire first three years of the experiment in the Dayton, Seattle, and the two Massachusetts sites. We excluded individuals with partial periods of participation: newborns, adoptees, suspended participants (e.g., those who joined the military), participants who voluntarily attrited, and persons who were involuntarily terminated for noncompliance during the first three years.

Newborns were analyzed separately. We selected only the 97 who were born at least 18 months before the end of the third year of the study, and used them only in analyzing the frequency of childhood immunization. We cannot observe the change in health status for this group.

Table 2.1 shows the sample for the analysis of preventive-care effects by site relative to the HIE enrollment sample. The 3661 people in the sample used for our analysis include 1786 males and 1875 females. Newborns are excluded.

Table 2.1

ANALYSIS SAMPLE VS. ENROLLMENT SAMPLE

Site	Analysis Sample	Enrollment Sample
Dayton, Ohio	1059	1140
Seattle, Wash.	1093	1222
Fitchburg, Mass.	669	723
Franklin Co., Mass.	840	889
Total	3661	3974

UNIT OF ANALYSIS

The unit of analysis is a person. We use the person rather than the family because the major determinants of use and health status are individual rather than family characteristics. We allow for family variables both through observed family variables (e.g., income) and by allowing for correlated residual behavior among family members.

DEFINING PREVENTIVE CARE

A definition of "preventive" was required to quantify preventive visits both as independent variables and as outcomes. Standard nomenclature describes three levels of preventive care: primary, secondary, and tertiary.

Primary preventive care is that set of activities taking place with a healthy person to prevent the development of disease. It includes personal behavioral change (exercise or cessation of smoking), inoculations against disease, and public health measures such as mosquito abatement. Our study considers only a subset of primary preventive activities--those involving personal choice, e.g., inoculations (this subset does not include behavioral changes, however).

Secondary preventive care is generally defined to include activities taking place before disease is recognized, but is in fact present. Screening examinations are a classic example of secondary prevention.

Tertiary preventive care is typically defined as that set of medical activities designed to limit the effects of a known disease, e.g., routine examinations of a diabetic person to test for changes in blood sugar level.

Our focus on medically provided and personally undertaken preventive care arises because some of the relevant policy questions depend upon knowing about the amount of such activity in a general population and its efficacy with respect to reducing medical costs and maintaining health. Further, knowing how receipt of these types of preventive care respond to changes in health insurance coverage is important in the planning for optimal public and private health insurance coverage.

For these reasons, we focus on primary and secondary preventive care. Inclusion of tertiary would define virtually all medical care as preventive. If the important public policy choices focus on whether preventive care should be accorded different treatment than nonpreventive (acute and chronic), then such choices are likely to draw narrow limits if special status is chosen for preventive care. Thus the more narrow definition of preventive care seems appropriate.

Dental care, vision and hearing exams, and mental health care are excluded from our analysis. We omit dental care because the gains from prevention accrue over a longer time horizon than can be seen in our three years of data. Vision and hearing exams conducted separately from general physical exams are generally in response to specific symptoms needing treatment (e.g., poor vision or hearing), and thus are not preventive. Likewise, mental health care is ordinarily related to existing problems that impelled the patient to seek professional help.

We also excluded pregnancy care. This is not to deny its importance; quite the contrary, the literature supports the efficacy of prenatal care strongly. However, our data are poorly suited for such a study. The primary beneficiary of maternity care is the newborn, not the mother. The period of observation on children born into the HIE study is too short to analyze the beneficial effects of prenatal care. Also, the sample of births is relatively small for any adequate analysis.

We consider only those outpatient visits that involve a face-to-face contact between a health provider and a patient. Within that set, an ambulatory visit is considered preventive if it has any component of preventive evaluation (e.g., a gynecological exam) or treatment (e.g., an immunization). Inpatient admissions are always treated here as nonpreventive.

A single visit may contain both preventive and nonpreventive services because patients often see physicians for more than one health problem during a visit. In such a case, the visit is counted as both a preventive and a nonpreventive visit. The charges for specific preventive and nonpreventive services are summed separately within the visit. The office visit fee is allocated between preventive and

nonpreventive services by prorating the fee over the diagnoses for the visit (if one third of the diagnoses are related to preventive care, then one third of the fee is added to preventive cost and two thirds to nonpreventive cost). See Sec. VI for further details.

DEPENDENT VARIABLES

The use of medical services has been separated into the following types. Each type is further divided into counts of visits involving the relevant medical service and into the cost of each of these visits. (As noted earlier for preventive care, each of these excludes mental, dental, and pregnancy items.) Measures are per person in each of three years unless stated otherwise.

(1) Use of preventive outpatient services;
(2) Use of inpatient services;
(3) Use of any nonpreventive outpatient services; and
(4) Use of nonpreventive outpatient services associated with our preventive measure (preventive targetted).

Nonpreventive medical care is composed in part of the treatment of some things that can be prevented, or detected early, and others that cannot. Cervical cancer, for example, is preventable in the sense that early detection can reduce costs or save lives. But the common cold is not preventable. Our fourth category focuses on the subset of care that could be affected by preventive services.[1] This measure removes services and associated costs used in treating illnesses that are irrelevant "noise" from variation in the use of nonpreventive medical services.

This study also examines the change in health status over the three-year period. Below we describe our health status measure, GHINDX. We use the change in GHINDX from enrollment to the end of the third year of the HIE as our measure of change in health status.

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[1]See Table 6.12 for a detailed listing of these services.

INDEPENDENT VARIABLES

Receipt of Exogenous Physical Examination. This consisted of an examination at the beginning of the HIE, approximately comparable to an "executive physical."

Findings from the initial examination were sent to a physician designated by the participant. If the person did not have a regular physician, he or she had to choose one from a list of available providers. The physician was responsible for any follow-up. The most important limitation of the examination was that it did not include any inoculations against contagious disease, a rectal, cervical, or testicular examination, or a Pap smear. The examination included a medical history questionnaire plus laboratory and other tests for nearly two dozen chronic diseases or complaints. The exact testing procedure is described in Smith et al. (1978). Some of the procedures included were blood alcohol levels, bilirubin tests, hematocrits and hemoglobin tests, ECG, chest X-ray, serum cholesterol, 2-hour post-load glucose tests, tonometry, blood pressure, spirometry, vision and hearing tests, BUN, and creatinine.

Preventive Care Measures. We analyzed the effects of receiving preventive measures. These included any disease-specific measures (such as immunization, screens for cancer, diabetes, TB, kidney and liver disorders, and cardiovascular problems) as well as any patient- or physician-initiated annual physical, administrative exam, multiphasic exam, or well-child-care visit.[2]

Variables constructed for this analysis include the following:

- Indicators for having had preventive care in previous years of the study;
- The average annual number of preventive visits during the study; and

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[2]Pap smears and tuberculosis tests were not considered preventive if cervical cancer or tuberculosis, respectively, were diagnosed earlier or suspected when the test was administered. See Table 6.11 for a detailed listing of preventive services.

- The deviation of a participant's number of preventive visits in a given year from his annual average.

Insurance Plan Variables. We have used four dummy variables to represent the insurance plans, one for each of the coinsurance levels (25, 50, and 95 percent) and the individual deductible plan. The free care plan is used as the basis for comparison.

Measure of Health Status. We used a measure of general health status at enrollment to predict use of services. The General Health Index (GHINDX) is a subjective measure reported by the patient himself. However, reliability and validity of the GHINDX have been extensively studied and documented (Ware, 1976; Davies and Ware, 1981). Section VI describes the GHINDX more fully.

Other Covariates. The model used in our analysis also included covariates for other experimental treatments, age, gender, race, family income, and family size. With the exception of family size and income, the data were collected before or at enrollment in the study.

STATISTICAL METHODS

Our analyses involve two basic types of models. The first is a regression model with a continuous dependent variable. The continuous dependent variables are (log) cost of (preventive, outpatient, and inpatient) medical services for a visit or admission and change in health status (GHINDX) over the first three years of the HIE. The second type is a negative binominal model for integer counts. The counts are for preventive visits, for outpatient nonpreventive visits, and for inpatient admissions for a given person in a given year. In addition to results based on these models, we report simple tabulations and proportions and corresponding statistical tests.

Both the regression models and the count models are based on three years of data for each participant (panel data with three replications) and for the several members of a household. The three observations for the same person will generally not be independent, because of the effects of unmeasured individual characteristics that do not change rapidly over time. Similarly, members of a household are more similar

in their behavior than a randomly chosen set of persons. These sources of correlation are termed heterogeneity among individuals and households. The nonindependence of observations means that the effective size of the sample is reduced. Our statistical procedures incorporate these sources of correlation and statistical tests are based on corrected calculations. These issues are discussed in more detail in Sec. VIII.

For each of the basic model types, we use two basic specifications of the explanatory variables (covariates). The first (termed ANOVA) includes only a minimal set of explanatory variables: indicator variables for year of observation; indicator variables for having received the randomly assigned entry physical exam, interacted with the year variables; and in some cases the average annual number of visits involving preventive care sought by the person, and the deviation of the prior year from the three-year average. The second expanded set of explanatory variables includes a range of variables reflecting age, gender (and other demographic variables as well), initial health status, cost-sharing plan, and other experimental variables discussed above. In the overview sections, we have drawn out relevant comparisons, and have simply indicated whether other covariates were included. Tables reporting full sets of equations, and in some cases further results, are reported in the technical sections.

III. PREVENTIVE CARE: STANDARDS AND USE

In recent years, increasing attention has been devoted to identifying procedures that might help prevent some diseases or reduce their social costs among segments of the population that are especially at risk. In 1979 the Canadian Task Force on the Periodic Health Examination outlined such a set of "targeted" preventive procedures, along with recommended frequencies of administration. In following years, the American Cancer Society (ACS), the American College of Physicians, the American Academy of Pediatrics, and the American College of Obstetrics and Gynecology issued preventive-care recommendations for the diseases and populations with which they were most concerned.

Despite the increased awareness of the benefits of preventive care on the part of physicians and the general public, there is concern that many people do not receive recommended preventive procedures. Immunization rates for children are falling. Data from the Center for Disease Control (CDC) indicate that most one-year-olds have not had a complete set of immunizations for diphtheria, pertussis, tetanus, and polio. Data on preventive procedures performed on adults are scanty. A survey done for the ACS indicates that most cancer screening procedures are not performed as frequently as the ACS recommends. However, this survey was based on patient self-report, and the extent to which it reflects actual practice is unclear. Kosecoff et al. (1985) found poor compliance with the standard for pneumococcal and influenza vaccinations among patients seen in a university-based group practice, but whether this is a widespread phenomenon is not known.

In this section we

- Report the frequencies of use of preventive procedures by the HIE sample.
- Compare these frequencies with recommended standards.
- Estimate the costs of bringing persons not currently receiving the recommended procedures up to the recommended standards of use for these procedures.

Our major findings are as follows:

- Most infants are not receiving adequate immunization.
- Most adult women are receiving periodic pap smears for detection of cervical cancer, but few are receiving mammograms for detection of breast cancer.
- Adult men are receiving little preventive care at all.
- The cost of bringing an average person up to the standards recommended by the medical profession ranges from $11 per male to $95 per female.

In the following pages, we describe the standards of preventive care and discuss the results of our analysis. The tables in Sec. VII present our analytical output in much more detail. Because our analysis is based on claims data, the frequencies of those procedures may be underestimated if physicians do not always bill separately for them, particularly when they are part of a physical examination. Examples include rectal and stool guaiac exams and testicular examinations.

STANDARDS

Medical organizations (e.g., the Canadian Task Force, American College of Physicians, and the ACS) have varied in the frequencies of administration they have recommended for some preventive procedures. However, there is enough similarity among the recommendations to allow us to derive consensus standards of care that most physicians would probably find acceptable. (See Table 3.1.)

FREQUENCIES OF USE

Since the timing and nature of the standards differ with age group and gender, the following discussion is divided into subsections for children and adults. Table 3.2 presents the sample sizes on which this discussion is based.

Table 3.1

PREVENTIVE CARE STANDARDS

Procedure	Target Population	Frequency
Diphtheria-pertussis-tetanus	children	at 2,4,6,18 mos
Polio	children	at 2,4,6,18 mos
Measles-mumps-rubella	children	at 15-18 mos
Tuberculosis testing	children	at 15-18 mos
Tetanus immunization	age > 17	every 10 years
Pneumococcal vaccine	age > 65 and high-risk groups	once
Influenza vaccine age	age > 65 and high-risk groups	yearly
Pap smears	women	every 3 years
	high-risk women	every year
Mammograms	women > 50	every year
Stool guaiac	adults > 40	every year
Sigmoidoscopy	adults > 40	every 5 years

Table 3.2

SAMPLE SIZES

Age-Sex Group	Sample Size
Males 17-44	819
Males 45-65	248
Females 17-44	878
Females 45-65	331

Children

During the first 18 months of life, the bulk of recommended preventive care consists of immunizations and well-care examinations. We first examined the proportion of children having a complete set of immunizations by the age of 18 months. Because a child is not considered to have adequate immunity against diphtheria, pertussis, tetanus (DPT), or polio unless he/she has received at least three doses of DPT vaccine and three doses of polio vaccine, we used those dosages as standards.

A total of 97 children were both born into the HIE *and* had at least 18 months of participation during the first three years of the HIE. Although this sample is small, it enables us to obtain estimates of the frequency of immunization. Only 44 percent of the children received three doses of DPT vaccine by the time they were 18 months old, and 45 percent received three doses of polio vaccine (see Table 3.3). This is not discrepant with the CDC's estimate that 37 percent of children under one year old have received three doses of DPT, and 24 percent have received three doses of polio vaccine. Only 61 percent of the HIE sample of newborns received a measles-mumps-rubella vaccine, and 55 percent had skin testing for tuberculosis. Because childhood immunization is often delayed owing to intercurrent infection, we used three, rather than four, immunizations as a standard for complete immunization.

We also examined the annual frequency of immunization in older children and calculated the probability of receiving at least one immunization in a given year of life. These estimates indicate that the probability of receiving any immunization during a year drops from 74 percent in the first year to 8 percent in the fourth year. It then

Table 3.3

AVERAGE USE OF PREVENTIVE SERVICES FOR INFANTS IN THE FIRST 18 MONTHS

Procedure	Standard[a]	Percent Meeting Standard
Immunization		
DPT	3	44.3
Polio	3	45.4
MMR	1	60.8
Tuberculosis testing	1	55.0

[a]Number of doses recommended in first 18 months. Sample size = 97.

rises to 37 percent in the sixth year, probably reflecting school admission requirements. (See Table 3.4.)

We also examined the time profile of preventive care use for children. Figure 3.1 displays the cumulative probability that a child will *not* have received certain preventive services by age 7.[1] The

Table 3.4

PROBABILITY OF UTILIZATION IN A GIVEN YEAR: CHILDREN
(Standard errors in parentheses)

Preventive Procedure	Age 0-1	Age 1-2	Age 2-3	Age 3-4	Age 4-5	Age 5-6
Immunization						
Any	.7405	.6769	.1286	.0833	.2414	.3663
	(.03885)	(.0419)	(.0283)	(.0239)	(.0355)	(.0377)
DPT	.70229	.4769	.5714	.04545	.1655	.2500
	(.04044)	(.0462)	(.0196)	(.0180)	(.0309)	(.0339)
POLIO	.67176	.4462	.5714	.04545	.1586	.2616
	(.04103)	(.0461)	(.0196)	(.0180)	(.0303)	(.0342)
MMR	.01527	.5615	.0357	.0303	.0483	.08721
	(.0107)	(.0431)	(.0157)	(.0149)	(.0177)	(.0214)
Any preventive	.9160	.7846	.5571	.4621	.5517	.5465
	(.0242)	(.0364)	(.0429)	(.0445)	(.0419)	(.0383)
Sample size (enrollees)	131	130	140	132	145	172

[1]We could not estimate directly the likelihood that a child would have certain immunizations by certain ages (e.g., 6) because our data cover only three years. We used a variant of life table methods to estimate the probability that a child would not have received a particular preventive service (e.g., an immunization) by a certain age. Using the children born during the study, we calculated the probability of no use in the first year of life. For each additional group, we used two-year periods. We calculated the probability that a two-year-old would not have any use in his second year, given that he had none in his first year of life, that a three-year-old would not have any use in his third year given that he had none in his second year, etc. Our estimate

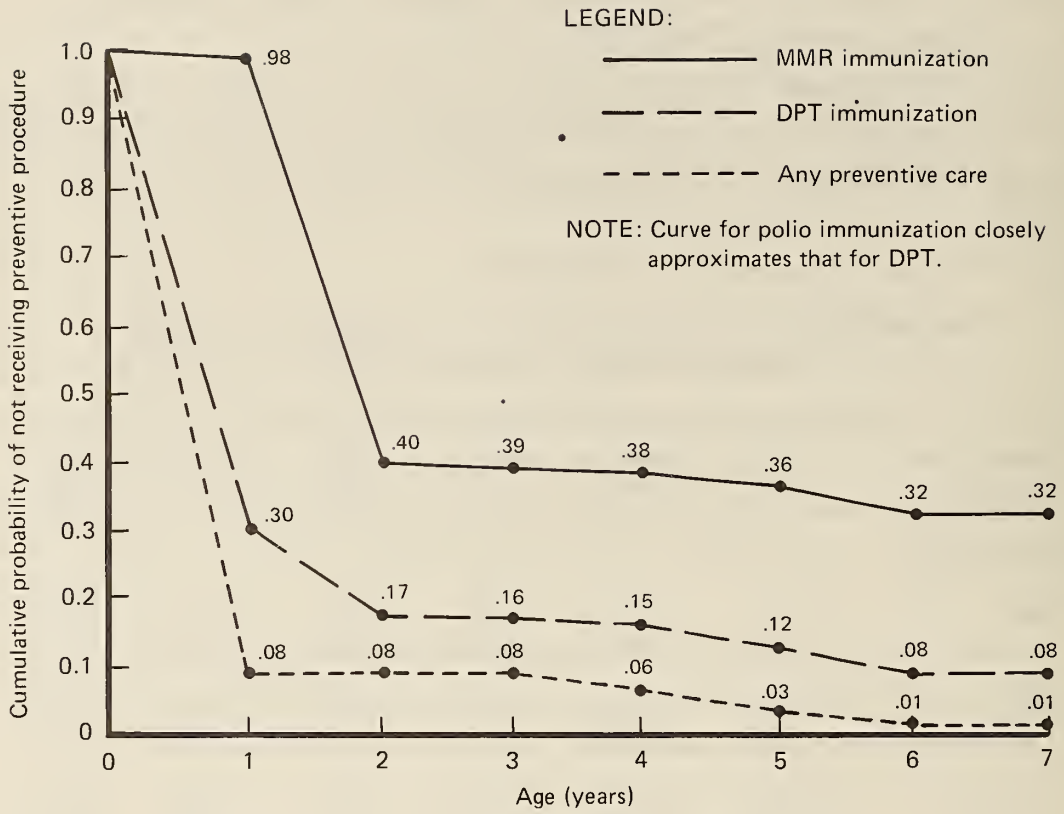

Fig. 3.1 -- Cumulative probabilities of failure of children to receive preventive care

services include any preventive services, any immunization, DPT, polio, and measles-mumps-rubella immunizations. Although 7 percent of children had no visits for preventive care in the first 18 months, we estimate that only 1 percent had not received any well care by age six. Nearly all children had had at least one DPT by age six, but a significant proportion had not received a measles-mumps-rubella shot.

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of the probability of no use by age x is the product of the probability of no use in the first year, the probability of no use in the second year (given none in the first year), the probability of no use in the third year (given none in the second year), etc.

Note that this is a biased (underestimate) of the true probability of no use. This bias comes from assuming that there is no repeat use. For example, we assume that if a three-year-old had no use in his second year, he had no use in his first year. Unfortunately, with only three years of data available to us, we cannot avoid using an assumption like this. To get a consistent estimate would require six or seven years of data on each child.

Adults

Preventive care for adults falls into several categories: immunization, cancer screening, screening for other disease, and counseling about health habits. Since physicians rarely bill separately for counseling about health habits, we cannot examine this activity with HIE claims data.

Immunizations. Tetanus immunizations, recommended at ten-year intervals, are the only immunizations routinely recommended for healthy adults under age 65. One percent of the study sample received tetanus immunizations purely for preventive purposes, i.e., unrelated to trauma (see Table 3.5). Even allowing for the fact that this analysis covers only three years and that these figures do not include claims for accident-related tetanus immunization, this rate of vaccination is low.

For adults under 65, immunization against influenza and pneumococcal pneumonia is recommended only for those with chronic disease. Influenza and pneumococcal vaccines were administered to 7.6 percent of adults aged 45-65 and to 1.6 percent of adults 17-44 at least once during the first three years of the HIE. Patients with diabetes or chronic lung disease should receive influenza vaccine. Ten percent of

Table 3.5

AVERAGE ADULT USE OF IMMUNIZATIONS
(Standard errors in parentheses)

	Percent with Any in 3 years	
Immunization	Age 17-44	Age 45-65
Influenza or pneumococcal pneumonia	1.6 (0.4)	7.6 (1.2)
Tetanus	1.4 (0.3)	1.0 (0.4)

SOURCE: Table 7.11, Sec. VII.

the HIE sample had these conditions and should have received annual flu vaccines.

Cancer Screening. Pap smears were the most frequently performed cancer-screening procedure. About 66 percent of women aged 17-44 received at least one Pap smear in the three years of the study (see Table 3.6). The procedure was performed less often in women aged 45-65, with 56 percent receiving a Pap test once in three years. Only 11 percent of women in both age groups received annual Pap smears.

Some groups recommend annual Pap smears for younger, low-income women since they have a greater risk of developing cervical cancer. In this analysis, high- and low-income women had Pap smears with similar frequency. Although these frequencies indicate that the majority of women received at least one Pap smear during the three-year period, they still indicate marked deviation from a 100 percent standard.

In contrast to the high frequency of Pap tests, women in the HIE rarely received mammography. Only one percent of women aged 17-44 and 2.4 percent of those 45-65 received this as a preventive measure once during the first three years of the study. Even when our count includes mammograms performed for nonpreventive reasons during the first three years of the HIE, we find that only 4 percent of women aged 17-44 and 7.8 percent of women aged 45-65 received mammography. This compares poorly with the standard, which requires a yearly mammogram for 75 percent of our sample over age 45.[2]

A fairly high percentage of women had at least one visit for some kind of preventive care over the three-year period; 78 percent of women aged 17-44 and 70 percent of those aged 45-65 made at least one visit that included preventive care during the study period. These data allowed us to place an upper bound on the frequency of use of procedures that we could not evaluate independently because they were not always billed for separately. For example, at most 70 percent of women 45-65 could have received a stool guaiac examination during the three-year period, and at most 19 percent could have had them annually. The actual

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[2]We chose a standard requiring mammograms for women over 50. Approximately 75 percent of the women in the 45-65 age group are over 50.

Table 3.6

AVERAGE ADULT USE OF CANCER-SCREENING PROCEDURES
(Standard errors in parentheses)

Preventive Procedure	Percent with Any in 3 Years			
	Females 17-44	Females 45-65	Males 17-44	Males 45-65
Pap smear	65.6[a] (1.6)	56.5[a] (2.7)	NA	NA
Pap smear or gyn exam[b]	70.0 (1.6)	58.6 (2.7)	NA	NA
Mammogram	1.1 (0.4)	2.4 (0.8)	NA	NA
Sigmoidoscopy	0.3 (0.2)	0.6 (0.4)	0.2 (0.2)	0.4 (0.4)
Chest X-ray	3.6 (0.6)	6.3 (1.3)	4.3 (0.7)	6.8 (1.6)
Any preventive procedure	77.9[c] (1.4)	70.1[c] (5.2)	23.2 (1.5)	29.8 (2.9)

SOURCES: Tables 7.12-7.13.

[a]Percent with at least one in each year = 10.9 for 17-44, 10.9 for 45-65.

[b]Some physicians might not have billed separately for Pap smears given during gynecological examinations; this row thus gives maximum possible frequencies for Pap smears.

[c]Percent with at least one in each year = 19.2 for 17-44, 17.8 for 45-65.

frequencies are probably much lower because not all such visits include stool guaiac exams.

In contrast to women, men received almost no cancer-screening procedures. Only 23 percent of men 17-44 and 30 percent of those 45-65 received any preventive care at all over the three-year period. Therefore, the fractions receiving a rectal/stool guaiac exam or a

testicular exam could not have been higher than these percentages, and they were probably much less.

The American Cancer Society (ACS) recommends sigmoidoscopy every three to five years for men and women over age 50. Only 94 persons in our sample (2.6 percent) had sigmoidoscopies during the three-year period, and only two (less than 1 percent) of those were performed as preventive measures.

Routine chest X-rays are not recommended by either the Canadian Task Force or the ACS, but are mentioned here because some physicians perform them routinely as part of a general physical exam. They were administered to less than 10 percent of the persons in each of the age-sex groups in our sample.

There is neither agreement nor established standards for tests to screen for diseases other than cancer. Therefore, we report data on the frequency of performance of such tests (in Table 3.7) but do not comment on standards for their performance. Women were more likely to receive complete blood counts (CBC) than men. Six percent of adults aged 17 to 44 and 12 percent of those age 44-65 received some blood test other than CBC--usually a multichannel test--as a preventive procedure. EKGs for preventive purposes were performed less often than blood tests.

There are multiple explanations for these findings of low use of preventive procedures. They include inadequate patient and physician education about the importance of such preventive procedures, as well as

Table 3.7

AVERAGE ADULT USE OF MEASURES TO PREVENT DISEASES OTHER THAN CANCER

Preventive Procedure	Percent with Any in 3 years			
	Females 17-44	Females 45-65	Males 17-44	Males 45-65
Complete blood count	12.9	14.8	6.7	6.4
Other Blood tests	5.5	12.5	5.4	10.4
EKG	3.4	10.0	3.5	7.2

the fact that not all physicians will subscribe to all of the standards mentioned here. For example, Romm, Fletcher, and Hulka (1981) found considerable disagreement about the appropriateness of some preventive procedures among a group of North Carolina physicians.

CHARGES FOR ATTAINING STANDARDS

Although there is increasing concern that herd immunity is decreasing in American children, it is difficult to calculate the numbers of cases of diphtheria, pertussis, tetanus, or polio that might occur with the high level of incomplete immunization reported above because data are not available.

Likewise, in adults, there is good evidence to suggest that early detection of cervical, breast, and colon cancer can decrease mortality from those diseases. Although we cannot confidently estimate the extent to which life expectancy would be extended by screening all adults, we can estimate the charges involved in bringing the HIE sample up to 100 percent compliance with standards for Pap smears, mammography, sigmoidoscopy, and stool guaiac examinations. These estimates are based on the following assumptions:

- All procedures are done in a physician's office.
- The charge for a person *with no* physician visit during the HIE equals the charge for an intermediate visit plus the charge for the procedure(s) in question.
- The charge for a person *with* a previous physician visit equals the charge for the procedure in question or the charge for the procedure in question plus the charge for upgrading a visit from intermediate to extended.
- The figures given are in 1984 dollars.

The charge over the three-year period to bring a person up to standard is small (see Table 3.8). It would be about $22 more per person than is now spent, to ensure that every child had a complete set of immunizations by 18 months. It would be about $10 to bring men up to the level of at least one well-care examination (a testicular exam or

stool guaiac test) in three years. The charge would be about $7 per woman for at least one well-care visit with a Pap smear. If mammography were included every three years, this would rise to about $94.

However, this analysis does not take into account the charges for the following: investigating false positive tests, hours of work lost in obtaining the procedure, unnecessary or nonrecommended tests that might be performed during an additional visit, worry or concern that might be raised by undergoing the procedure, and any complications that arise as a result of the procedure.

Our estimates of the per-person charge for achieving the recommended standards assume that the services will be rendered in a physician's office. There may be substantial cost savings if mass screening techniques and ancillary personnel are used. See Moscowitz and Fox (1979).

Table 3.8

CHARGES TO BRING AN HIE ENROLLEE UP TO PREVENTIVE CARE STANDARDS BY END OF 3 YEARS
(In 1984 dollars)

Sex and Age Group	Well-Care Visit	Pap Smear	Pap Smear and Mammogram
Male, 17-44	11.30	NA	NA
Male, 45-65	8.81	NA	NA
Female, 17-44	3.52	7.63	94.62
Female, 45-65	1.79	6.95	93.86

SOURCES: Based on Tables 7.32 and 7.33. For example, $7.64 = 0.064 (28.61 + 12.55) + 0.155 (10.85 + 12.55) + 0.121(12.55),
where 0.064 = probability of no use in 3 years
0.155 = probability of only nonpreventive use in 3 years
0.121 = probability of preventive use but no Pap in 3 years;
28.61 = cost of office visit;
10.85 = cost of upgrading visit; and
12.55 = cost of Pap smear.

Given the incidence of various cancers, we can estimate the incremental charge per cancer detected. These estimates are $50,000 for a new case of breast cancer, $20,000 for colorectal cancer and $80,000 for a confirmed case of cervical cancer. These numbers are based on the assumptions that all cases are detected by screening and none would have been detected otherwise.

Effects of Cost-Sharing

Table 3.9 shows the effect of cost-sharing on the likelihood of any use of preventive care for children. Cost-sharing was associated with a significant reduction in immunizations for children under age seven and in the percentage of both younger and older children who received any preventive care.

Table 3.9

EFFECT OF COST-SHARING ON PREVENTIVE CARE FOR CHILDREN

Age and Type of Care	Percent with Any Preventive Care in 3 Years		
	Free	Family Coinsurance Plans	Individual Deductible
Aged 0-6			
Immunizations	58.9	48.7[a]	50.4
Preventive Care	82.5	73.7[a]	77.9
Aged 7-16			
Immunizations	21.2	21.7	16.1
Preventive Care	64.8	59.6	53.2[a]

SOURCES: Tables 7.7, 7.8.

[a]Significantly different from the free plan ($p < 0.05$).

The effects of cost-sharing on use of immunizations and other preventive care by adults are shown in Tables 3.10 and 3.11. Because of the low frequency of immunizations among adults, we did not estimate cost-sharing effects by age *and* sex. We were, however, able to examine such effects by age. There was no statistical difference in free and coinsurance plans in the use of immunizations for younger adults. In contrast, older adults on the free plan tended to receive more immunizations than those in cost-sharing plans. While there was a difference in use of preventive care only for younger males on the individual deductible plans, older males on the free plan received slightly more preventive care than those on the cost-sharing plans, but the difference was not statistically significant. Women in both age categories who were on the free care plan received more Pap smears, and women aged 45-65 had more preventive care in general than those on cost-sharing plans.

Table 3.10

EFFECT OF COST-SHARING ON IMMUNIZATIONS FOR ADULTS

	Percent with Any Immunization in 3 Years		
Age	Free	Family Coinsurance Plans	Individual Deductible
Adults 17-44	6.4	5.4	3.1[a]
Adults 45-65	15.7	8.2[a]	6.8[b]

SOURCES: Table 7.20.

[a]Significantly different from the free plan ($p < 0.05$).

[b]Significantly different from the free plan ($p < 0.01$).

Table 3.11

EFFECT OF COST-SHARING ON PREVENTIVE CARE FOR ADULTS

Age Group and Type of Care	Percent with Any Preventive Care in 3 Years		
	Free	Family Coinsurance Plans	Individual Deductible
Males 17-44, preventive care	27.2	23.1	17.2[b]
Males 45-65, preventive care	39.1	27.4	18.8[b]
Females 17-44,			
Pap smears	72.2	65.8	54.8[b]
Preventive care	83.7	76.9a	71.1[b]
Females 45-65			
Pap smears	65.0	52.8a	50.0[a]
Preventive care	76.9	65.3a	68.6

SOURCES: Tables 7.22, 7.23, 7.24.

[a]Significantly different from the free plan ($p < 0.05$).

[b]Significantly different from the free plan ($p < 0.01$).

For outpatient care in general, we observed lower use of both preventive and nonpreventive services as cost-sharing increased; see Table 3.12. With the exception of the Individual Deductible plan, we observed a greater response for nonpreventive care than we did for preventive care. For example, preventive use fell 1 percent between the free and 25 percent family coinsurance plans, but nonpreventive use fell 18 percent between the two plans. This runs counter to the common wisdom that people may be more sensitive to cost-sharing for preventive services than they are for nonpreventive services, because preventive services are assumed to be more discretionary. Such an argument has two flaws. First, preventive care may not be as discretionary as some

Table 3.12

EFFECT OF COST-SHARING ON OUTPATIENT VISIT RATES
AS A PERCENTAGE OF THE FREE PLAN RATES
(t-Statistics relative to free plan)

Plan	Preventive Care (%)	Nonpreventive Care (%)
Free	100.00 (---)	100.00 (---)
25 percent	99.0 (-2.25)	81.7 (-5.08)
50 percent	84.4 (-2.66)	67.4 (-6.61)
95 percent	71.0 (-7.38)	62.3 (-11.28)
Individual deductible	71.3 (-7.07)	68.9 (-8.75)

SOURCES: Tables 9.1 and 9.3.

assume, because a well-care examination and up-to-date immunizations are often required for school-age children. Second, much of the nonpreventive use was for self-limiting, and hence discretionary, health problems, such as upper respiratory illnesses.

That cost-sharing appears to have some effect on use of individual preventive-care services is not surprising in view of the large effect of cost-sharing on use of health services in general (Newhouse, Manning, Morris et al., 1981, 1982). The low frequency with which people on the free care plan received preventive services implies that cost-sharing was not the only obstacle to the receipt of these services.

IV. EFFICACY OF PREVENTIVE CARE

To assess the effects of preventive care on the use of health services and on health status, we conducted two sets of analyses. First, we examined the effect of the physical examination given at entrance into the Health Insurance Experiment (HIE) to a random 60 percent of the study population. Because the results of that examination were reported to the person's regular physician, this exam is similar to a general well-care examination. The advantage of this entry examination over comparisons based on the analysis of nonexperimental use of preventive services is that the entry examination was randomly assigned. Hence there is no problem of the results being generated by adverse selection (e.g., sicker people selecting an examination). The disadvantage of this entry examination is that it did not include certain preventive procedures that are known to be efficacious; for example, it did not include updating immunizations, Pap smears, or testicular, cervical or rectal examinations. These are major components of the well care recommended by the Canadian Task Force, the American College of Physicians, and the American Cancer Society (ACS). This exam also differed from a well-care exam in that it was not conducted by the patient's regular physician.

Second, to overcome the potential for underestimating the effect of well care on health status and subsequent use of medical services due to the omission of these services from the entry physical examination, we also examined the effects of well care that the patient sought during the course of the study. The chief liability of this second approach is that there may be a selection bias if those who seek preventive care on their own are different in unobservable ways that lead to higher use of all types of health care.[1]

With both approaches, we find that preventive care has a negligible and statistically insignificant effect.

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[1]We have used statistical procedures designed to incorporate the unobserved sources of correlation in the types of health care.

In this section, we first examine the effects of the randomly assigned entry physical examination and of the preventive care sought during the study upon the subsequent use of health services, and then the effects of these on health status.

USE OF HEALTH SERVICES

Over the three years studied here, people receiving the entry physical examination averaged about $17 per person per year less in medical care expenses (in June 1984 dollars) than did people receiving no examination at entry. Although this is not a negligible amount when summed over several years, it is not statistically significantly different from zero ($t = -0.40$).

The lack of precision for this result could be due to several factors: (1) There may be no true effect; (2) the inclusion of relatively rare but large and skewed inpatient expenditures may have substantially increased the standard errors for sample means; (3) the inclusion of services where preventive care is not believed to be efficacious (e.g., upper respiratory infections) would have increased the noise in expenditures without affecting the true differences; and (4) the use of unbiased but inefficient analysis of variance (ANOVA) techniques would have degraded our precision relative to procedures that control for other covariates (ANOCOVA). We examined each of these last three directly to assess the validity of (1).

Excluding inpatient expenditures did increase the precision of our estimates of the effect of the entry physical examination on the use of health services. Averaged over the three years studied here, people receiving the entry exam had $15 per person per year less in outpatient health expenditures. This result is not statistically significant at conventional levels ($t = -1.47$); but a result of this magnitude or greater could have happened by chance with a probability of 14 percent (two-tailed test).

When we excluded services for illnesses that preventive care should not affect, we obtained qualitatively similar results. For the entry-exam group, annual total expenses averaged $34 per person less ($t = -1.15$), while outpatient expenses averaged $2.40 per person less

(t = -0.53). Interestingly, inpatient expenses were $32 per person per year less in the group receiving the entry examination, but this large a sum is statistically insignificant (t = -1.19).

As a final check of the null finding on the randomized entry examination, we employed multivariate techniques for counts of visits and admissions and costs per visit or admission to control for the effects of other explanatory factors (demographics, cost-sharing, and so forth--see Sec. IX). These techniques increased our precision by reducing the unexplained variation across individuals and removing any imbalance between the examined and unexamined populations. The ANOVA techniques described above are not adjusted for any residual imbalance in the samples.[2]

These multivariate techniques did increase our precision, by an amount that was roughly equivalent to a 35-to-40 percent increase in the sample size. Nevertheless, the results were still statistically insignificant. Table 4.1 shows the percentage change in the use of health services on counts of visits and admissions and on dollars per visit. These results are the partial effect of the examination after adjusting for any differences in the populations that did or did not receive the entry physical examination. The entry physical examination increased the number of visits and admissions by a statistically insignificant amount; all of the t-statistics are less than one. The average cost per visit for preventive and nonpreventive outpatient care was insignificantly lower for the group with the entry examination. The average cost per visit for "preventive targeted" nonpreventive care was insignificantly higher for the entry-exam group. The average cost of an admission was 11 percent lower (t = -2.05) in the group that had an entry examination. The net effect of higher visit and admission rates

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[2]Randomization guarantees that if you did the assignment of a very large population, on average the two populations would have the same mix of sick and well individuals. With the assignment of a finite sample, there is a small chance that one group is sicker than the other. For example, if you toss a fair coin once, then you get either a head or a tail. If you do it four times, there is one chance in sixteen that you will get only heads. If you perform the experiment a very large number of times, the proportion of heads will be close to half with very high probability. To correct for any imbalances, we used multivariate techniques.

Table 4.1

PERCENTAGE EFFECT OF ENTRY EXAMINATION
ON USE OF SERVICES
(t-Statistics in parentheses)

Service	Number of Visits (%)	Cost Per Visit (%)	Total Effect (%)
Preventive	5.1 (0.83)	-3.8 (-1.32)	1.13 (0.19)
Nonpreventive	3.2 (0.77)	-.51 (-0.16)	2.7 (0.52)
Preventive targeted	2.1 (0.28)	0.87 (0.16)	3.0 (0.32)
Inpatient	13.8 (0.95)	-11.0 (-2.05)	2.9 (0.16)

SOURCES: Derived from Tables 9.1, 9.3, 9.5 and 9.7 for number of visits and admissions, and Tables 10.1, 10.2, and 10.3 for cost per visit and per admission.

and lower costs per visit and admission was that there were small and insignificant differences in the use of health services between those who did and did not receive the entry examination.

We also examined the use of services by people who sought preventive care at their own or their physicians' initiative. Using ANOVA techniques, we found that total expenditures of people who had sought preventive care were a significant one third higher per person per year ($141, t = 3.50) subsequently than those who had not. This is in marked contrast to the insignificantly lower $17 per person per year from the entry physical examination. Of the two estimates, we believe in the results of the randomly assigned entry examination, because the randomization ensures that those who received the entry examination were just as sickly on average as those who did not receive the examination. In the case of those who use preventive services on their own, there is the risk that those who seek health care may differ from those who do

not. Based on the multivariate results in Sec. X, we know that those with low health status were more likely to seek preventive care than were those with average health status. By not controlling for this greater sickliness of patients who seek care, the ANOVA estimates provide a biased estimate of the effect of preventive care on subsequent use.

To eliminate this bias from the estimates, we used multivariate methods to correct for known differences, including health status (see Table 4.2) for the effects of preventive care on subsequent use of services. Controlling for known differences in age, health status, etc, reduced the effect of preventive care on study to a 9 percent increase in nonpreventive use, and a 12 percent decrease in inpatient use. These are smaller than the cumulative one-third effect obtained with ANOVA. In fact, the two multivariate effects largely cancel each other out.

Thus, once we control for differences between those who do and do not seek preventive care, we find no appreciable effect of well care on subsequent use.

Table 4.2

PERCENTAGE EFFECT OF PREVENTIVE CARE SOUGHT ON SUBSEQUENT USE OF SERVICES

Service	Number of Visits (%)	Cost per Visit (%)	Total Effect (%)
Nonpreventive	1.9 (0.20)	7.8 (2.14)	9.4 (0.92)
Preventive Targeted	28.4 (0.75)	6.3 (1.32)	31.1 (0.82)
Inpatient	-4.7 (-0.07)	-6.7 (-1.06)	-11.7 (-0.18)

SOURCES: Derived from Tables 9.3, 9.5, and 9.7 for number of visits and admissions, and Tables 10.1 and 10.2 for cost per visit and per admission.

These results closely parallel those found by Olsen, Kane, and Proctor (1976) in a nonrandomized study of multiphasic screening. The only significant finding was an increase in hospital days in the group receiving the multiphasic exam, leading them to be even more pessimistic than our results would suggest. Their study differed from ours not only because of differences in the type of preventive treatment, but because they measured changes in inpatient days rather than inpatient costs.

EFFECTS ON HEALTH STATUS

We have painted only part of the picture. The value of preventive care cannot be determined on the basis of cost savings alone. We must also assess whether there are gains to health status, and (if so) whether they are worth the cost.

To study this question, we analyzed the change in the General Health Index (GHINDX) over the course of the three years of our analysis. Recall that the GHINDX is scaled such that, over the three years of the study, it falls by nearly 3 points, other things equal. This provides a useful metric: One year of aging equals one point loss in the GHINDX. Alternatively, a 5-point difference in the GHINDX is equivalent to the effect of having hypertension (see Brook, Ware, Rogers et al., 1983).

We first conducted a simple analysis of variance (ANOVA) on the GHINDX change. The group who did not receive the HIE physical "aged" 2.48 units, while the group who did "aged" 2.22 units. Thus, the estimated effect of the randomly assigned entry physical exam was 0.26 units ($t = 0.45$)--a beneficial but small and quite insignificant effect.

Drawing on Table 11.1, we conducted similar analyses of the change in the GHINDX over time using multivariate analysis to adjust for known differences in the two populations. The estimated effect of the HIE entry physical is a gain of 0.13 units ($t = 0.22$) relative to the no-physical-examination group. Thus, these results resemble those from simple ANOVA analysis.[3] With either method of analysis, there is

[3]The change in GHINDX over three years has a residual distribution that is appreciably long-tailed. Using robust regression techniques, such as Huber's biweight, did not change our conclusions. Even when extreme observations were heavily downweighted, the t-statistics were less than 1.0.

sufficient precision to detect a difference of 1.2 units in the GHINDX between the groups with and without entry physical examinations. Thus we had the precision to detect an effect on health status equivalent to less than one third that associated with developing hypertension.

We also examined the effect of preventive care sought during the study on the change in the GHINDX. The results were similar to those found in the contrast of those who did and did not receive the entry physical examination. Using ANOVA, we found that those with preventive use during the study had an insignificantly higher exit score, by 0.14 units ($t = 0.29$). Using least squares to adjust for known differences between those with and without preventive care during the study yields an estimate of 0.22 units ($t = 0.39$). (See Table 11.1.)

V. SUMMARY

EFFECTS OF PREVENTIVE CARE ON USE OF HEALTH SERVICES AND HEALTH STATUS

In this report, we have examined the effects of adding a well-care examination for every one to the existing package of health care services that people receive in the Health Care Experiment (HIE). We found a small beneficial, but statistically insignificant, effect of a randomly assigned physical examination upon the use of health services and upon the person's health status after three years. Averaged over the three-year period, those who received the entry physical examination spent $17 per person per year less than did those who did not ($t = -0.40$). Those who received the entry examination also had insignificantly higher health status (0.26 units, $t = 0.45$); that amount is roughly equivalent to 5 percent of the differences in health status associated with having hypertension. When we examined the effects of preventive care that participants sought during the course of this study, we found the same pattern of statistically insignificant, small, beneficial effects upon health status. There was an insignificant increase in health status of 0.14 units of the health index, GHINDX ($t = 0.29$); that amount is roughly equivalent to 3 percent of the differences in health status associated with having hypertension. In contrast, those who sought preventive care during the study subsequently had significantly higher expenditures ($141 per person per year, $t = 3.50$). When we controlled for differences between users and nonusers of preventive care, this result largely evaporated.

These results are insensitive to the manner in which the data are analyzed. With the exception noted above, we get the same results when we use relatively simple ANOVA as when we use multivariate techniques. We get the same results when we examine medical care in general as when we examine services for which preventive care could be effective.

Thus, it appears that *adding* a small amount of preventive care has no appreciable effect. This is not a judgment about the value of all preventive care, as a take-it-or-leave-it proposition. The benefits of

preventive care are impressive. Immunization against contagious disease has substantially reduced death and suffering, and all but eliminated some diseases. Early detection of certain diseases (e.g., cervical cancer by a Pap smear) has been critical to the survival of many.

Instead of addressing the desirability of preventive care in general, we have focused on the incremental value of additional well care.

These null findings could be due to several causes. First, there may be no appreciable gains from further preventive care. Second, the sample in our study may not be large enough to detect clinically meaningful effects for specific conditions in a general population. For example, the sample is so small that the study would have only a few cases of new cancer over the three-year period. Third, with a duration of three years, we may not have adequate time to see the full effects of early detection and treatment of disease. Fourth, the beneficial effects of a general preventive examination may be partially offset by adverse effects associated with false positives, labeling of patients, and resultant changes in health perception and adverse reactions. If this dilution of benefit is the source of our null findings, then the incremental value of a general well-care examination may be truly small or negative on net account.

The effect of preventive care is probably greater for those who have not received preventive care recently than for those who have for the latter, in fact, it may add no benefit at all. Thus an untargeted approach may have diluted the benefit that could have been realized from a targeted program for a needy population. Unfortunately, we could not tell which conditions were known by a patient's physician.

Finally, the lack of an effect could be due to imperfections in reporting findings to providers, or to a failure of providers to respond.

FREQUENCY OF PREVENTIVE USE

We found that many people--especially adult males--are not getting the recommended levels of preventive care. Over the three years of the study, only a quarter of the men had any use of preventive services. Two thirds of the women received the recommended Pap smears, but few

received mammograms. Most children did appear to eventually get some of the immunizations that they need, but they did not get them on schedule. Less than half of the children 18 months and younger had had the recommended DPT and polio vaccines. There was some tendency to wait until children had to have the immunizations for school.

How much more would it cost than we are now spending, to ensure that each person got the recommended levels of well care? We estimated that it would cost about $10 per man to bring men up to a level of at least one well-care visit (with a rectal examination) in three years. It would also cost nearly $10 per woman to bring women up to a standard of at least one well-care visit with a Pap smear in three years, and $116 per woman aged 45-65 if a mammogram were included in the three-year standard. It would cost about $22 more per child than is now spent to ensure that every child had a full set of DPT and polio shots by age 18 months. These dollar estimates are probably too low, because they do not include the cost of adverse immunization reactions, false positives, or the time-costs of the patients.

These costs seem very low because they are per-person costs. A more relevant cost is the cost per new case discovered or per new case averted. Given the incidence of breast cancer, the cost per new case discovered is about $50,000, while that for rectal cancer is about $20,000, and for cervical cancer (as distinct from cervical epithelial abnormality) is $80,000. These costs could be reduced by the use of mass screening techniques.

Pap smears were performed much more frequently than mammograms. There are several possible reasons for this. First, patient education has been more effective in convincing women of the importance of Pap smears. Secondly, the low use of mammography may be due to residual concern about the possible harm of radiation in mammography during the time of the HIE. Finally, mammograms are much more expensive than Pap smears and require a separate visit. The high cost of mammograms may discourage use when patients have to pay part of the costs (but use was low even under the free plan).

COST-SHARING AND THE USE OF PREVENTIVE SERVICES

Some people believe that cost-sharing for outpatient care, and particularly preventive care, is a major deterrent to people getting the preventive care that the medical profession recommends. Some even believe that if preventive care were free to the patient, it would pay for itself in future cost savings. Our data show that preventive care does respond significantly to out-of-pocket costs, but preventive care is less responsive to cost-sharing than is nonpreventive care.

Although cost-sharing is an important determinant of the use of services, it is not the only one. When we look at the HIE free plan, which is much more generous than those commonly available, we find that substantial fractions of the enrollees are still not getting the well care that the medical profession recommends. For example, we found that, over a three-year period on the free plan: Only a third of the adult males had any preventive care; only four-fifths of the women had any preventive care; only four-fifths of the children under 6 and two-thirds of those aged 7 to 16 had any preventive use. There was negligible use of mammography services by women on the free plan.

LIMITATIONS

This study has several major limitations. First, the HIE excludes the aged, who account for a disproportionate share of total health expenditures and most of the deaths. As a result, we are unable to obtain an estimate of the effect of preventive care on life expectancy, nor are we able to include the very large health-care costs in the last years of life.

Second, because the study covers only three years, we cannot estimate the long-term consequences of either the entry physical examination or of preventive use during the study. This limitation is very important for diseases that take a long time to run to conclusion (e.g., cancer and hypertension).

Third, the sample is too small to look at the efficacy of certain screening procedures, especially for cancer. Given national estimates of the incidence of cancer, we would expect to see three new cases each of rectal and breast cancer and one-half a case of new cervical cancer during the three-year period in a sample of the size in the HIE.

Fourth, we have relied heavily on the well-care aspects of a randomly assigned general physical examination. That examination did not include many of the well-care services recommended by the medical profession: rectal examinations, gynecological examinations and Pap smears, and updating immunizations. By excluding these services, we may have missed major benefits from well care. To minimize the effects of these omissions, we also examined the effect of well care that patients sought during the course of this study. Unfortunately, some of the services were used so rarely (e.g., mammography) that we cannot comment on their efficacy.

Finally, the HIE screened a random sample of the population, rather than targeting those in need. Any ordinary screening program would probably try to reach people who are not receiving adequate immunizations and screening procedures through other programs or their private physicians.

Part 2

TECHNICAL SECTIONS

VI. DATA AND VARIABLE DEFINITIONS

The preceding general sections provide an overview of our methodology and a summary and discussion of our results and conclusions. The following technical sections contain a detailed discussion of our data and methodology plus a full tabular presentation of our results.

INTRODUCTION

The data used in this analysis were drawn from claims files produced by the Health Insurance Experiment (HIE) conducted by Rand. Fuller background information on the HIE is given here. We also describe the construction of our analysis files from the HIE data and of the variables used in the analysis.

HEALTH INSURANCE EXPERIMENT: DESIGN AND SAMPLE

The HIE is a randomized trial of the effects of different health insurance policies on the demand for health services and on people's health status. The HIE was designed to overcome many of the shortcomings of nonexperimental studies (especially the bias from self-selected insurance coverage), so that it could provide unbiased estimates of the effects of cost-sharing.[1]

The Design

The HIE enrolled families in six sites: Dayton, Ohio; Seattle, Washington; Fitchburg, Massachusetts; Franklin County, Massachusetts; Charleston, South Carolina; and Georgetown County, South Carolina.[2] This analysis uses data from the first four of these sites. In each site, families enrolled for either three or five years.

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[1]Newhouse (1974) and Brook et al. (1979), provide fuller descriptions of the design. Newhouse et al. (1979) discuss the measurement issues for the second generation of social experiments, to which the HIE belongs. Ware et al. (1980) discuss many aspects of data collection and measurement for health status.

[2]The experiment started between November 1974 and February 1975 in Dayton; between January and September 1976 in Seattle; between July and October 1976 in Massachusetts; and between November 1976 and February 1977 in South Carolina.

Families participating in the experiment were assigned to one of 14 insurance plans.[3] The plans had different levels of cost-sharing, which varied over two dimensions: the coinsurance rate and an upper limit on expenses. The coinsurance rates (percentage paid out-of-pocket) were 0, 25, 50, or 95 percent for all health services. Each plan had an upper limit (the maximum dollar expenditure or MDE) on out-of-pocket expenses of 5, 10, or 15 percent of family income, up to a maximum of $1,000.[4] Beyond the MDE, the insurance plan reimbursed all expenses in full. One plan had different coinsurance rates for inpatient and ambulatory medical services (25 percent) from those for dental and ambulatory mental health services (50 percent). Finally, on one plan, the families faced a 95-percent coinsurance rate for outpatient services, subject to a $150 annual limit on out-of-pocket expenses per person ($450 per family). In this plan, all inpatient services were free, so that, in effect, this plan had an outpatient individual deductible.[5] All plans covered the same wide variety of services.[6]

A simple example will illustrate how an HIE insurance plan works. Consider a family with a coinsurance rate of 25 percent for all services and an MDE of $1,000. For the first $4,000 ($1,000/0.25) of health care

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[3]In addition, the HIE had two groups (experimental and control) enrolled in a prepaid group practice or health maintenance organization (HMO). These enrollees belonged to the Group Health Cooperative of Puget Sound (Seattle) and were not included in our study.

[4]The limit was $750 for the 25 percent coinsurance plans in the Massachusetts and South Carolina sites, and in later years of the Dayton and Seattle sites. All dollar amounts are stated in nominal (actual) dollars and are not corrected for inflation.

[5]The coinsurance rate for the "95 percent" and Individual Deductible plans was 100 percent in Dayton year one. The rate was changed to 95 percent to increase the incentive to file in all other site-years, although there was no statistical evidence of underfiling.

[6]See Clasquin (1973) for a discussion of the reasons for the HIE structure of benefits. Nonpreventive orthodontia and cosmetic surgery (not related to preexisting conditions) were not covered. Also excluded were outpatient psychotherapy services in excess of 52 visits per year per person. In the case of each exclusion, it is questionable whether anything could have been learned about steady-state demand during the three-year or five-year lifetime of the experiment.

(dental, medical, and mental health care), the participating family pays 25 percent and the insurance plan pays 75 percent. After the first $4,000 of total expenditures, the family pays nothing out-of-pocket and the plan pays everything because out-of-pocket expenses have reached the MDE of $1,000.

As this example illustrates, the participant's response to an HIE insurance plan is an amalgam of responses to coinsurance rates and free care beyond the MDE. In this report, we examine the overall effect of the insurance plans as well as the effect of the entry medical exam and of past preventive care.[7]

To study methods effects, the HIE had three other randomized subexperiments. First, to increase precision in measuring changes in health status, some households were given a preexperimental physical examination; to test for a possible stimulus to utilization, the remaining households received no such examination. Second, to measure sick-loss days and telephone utilization, some households filled out a diary on contacts with the health care system. To test for Hawthorne effects, some households filled out no forms, some filled them out weekly, and some biweekly. Third, to test for transitory aspects of the study, some households were enrolled for three years, others for five.

Families were enrolled as a unit, with only eligible members participating. No choice of plan (or other experimental treatment) was offered; the family could either accept the experimental plan or choose not to participate. To prevent refusals, families were given a lump-sum payment equal to their worst-case financial risk associated with the plan; thus, no family was worse off financially for being in the study.[8] The amount of the lump-sum payment is independent of use of health care

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[7]Other reports decompose the participant's response-to-plan effect into his responses to the coinsurance rate and the MDE. Such analysis requires examining episodes of dental, medical, and mental health care, because the MDE applies to all three types of care. See Keeler et al. (1977, 1982) for a theoretical description of the effects of upper limits and deductibles, as well as some first empirical estimates of their separate effects.

[8]The family's nonexperimental coverage was maintained for the family by the HIE during the experimental period with the benefits of the policy assigned to the HIE. If the family had no coverage, the HIE purchased a policy on their behalf. Thus, no family could become uninsurable as a result of their participation in the study.

services. Thus, it should be considered a temporary change in income and should not affect the response to cost-sharing.[9]

Families were assigned to treatments using the Finite Selection Model (Morris, 1979). This model is designed to achieve as much balance across plans as possible while retaining randomization; that is, it reduces correlation of the experimental treatments with health, demographic, and economic covariates. The expected gain in precision from using this model rather than simple random assignment in the experiment is about 25 percent (Morris, 1979). Random refusals of the enrollment offer, about 15 percent in this experiment, degrade the 25 percent gain in proportion to the refusal rate (Morris, Newhouse, and Archibald, 1979).[10]

The Sample Enrolled

The HIE enrollment sample is a random sample of each site's population, but the following groups were not eligible: (1) those 62 years of age and older; (2) those with incomes in excess of $25,000 in 1973 dollars (or $58,400 in 1984 dollars); (3) those eligible for the Medicare disability program; (4) those in jails and those institutionalized in long-term hospitals; (5) those in the military or their dependents; and (6) those with military service-related disabilities.[11]

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[9]Some preliminary work on medical expenditures indicates that participants treat this payment as they would a transitory change in income. Only a small percentage of that payment appears to be used directly for medical expenses.

[10]Across all sites for the initial sample, 94 percent did not refuse the screening interview, 85 percent did not refuse the baseline interview, 76 percent did not refuse the offer of enrollment interview, and 65 percent did not refuse the offer of enrollment. If a family refused at any stage, it was excluded from the final sample. The plan-related refusal rate is 15 percent ((percentage not refusing enrollment interview minus percentage not refusing enrollment offer)/(percentage not refusing enrollment interview) = (76 - 65) × 100/76).

These numbers do not account for families who moved prior to enrollment or who could not be found at home, or other losses from the sample not due to refusal. It does not include families enrolled in Group Health Cooperative of Puget Sound (see Newhouse et al., 1982, pp. 5-7).

[11]See Clasquin and Brown (1977) for a description of the rules for the HIE, including the definition of eligibility.

PREVENTIVE CARE ANALYSIS DATABASE

The Sample Analyzed

The analysis sample used in this report consists of those enrollees who participated for a full three years in the first three years of the experiment in the Dayton, Seattle, and the two Massachusetts sites. Claims data from South Carolina were not available in time for our analysis. For analyzing the effects of preventive care, we excluded individuals with partial periods of participation: newborns, adoptees, decedents, suspended participants (e.g., those who joined the military), participants who quit the study, and persons who were involuntarily terminated for noncompliance during the first three years.[12]

Newborns were analyzed separately. Only those infants born into the study at least 18 months before the end of the three-year period were included. Newborns were only used in the analysis of frequency of use and compliance with standards for immunizations.

Table 6.1 shows the sample for the analysis of preventive-care effects by site and insurance plan. The 3661 individuals are divided into 1786 males and 1875 females. Table 6.1 excludes the 97 newborns in the sample.

Data Exclusions

To provide cleaner measures of preventive and nonpreventive care, our analysis excluded procedures administered and drugs prescribed by mental health specialists, dentists, chiropractors, Christian Science practitioners, podiatrists, and vision and hearing specialists. Procedures were identified by California Relative Value Studies (CRVS) codes[13] and by HICDA diagnosis codes.[14] Type of provider (e.g.,

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[12]We excluded such cases because we needed to observe entry- and third-year values for the health status variable. New entrants do not have entry values and early departures do not have exit values comparable to the rest of the population. Although the participants who left the study early had more physical limitations and were enrolled in less generous plans than the full three-year participants, preliminary work on the use of medical services indicates that except for deaths, early departures used health services at the same rate as full three-year enrollees with similar characteristics. These exclusions accounted for about 8 percent of the enrollment population.

[13]Codes were taken from the 1974 Revision, 5th Edition, of the

Table 6.1

ANALYSIS SAMPLE: FULL THREE-YEAR PARTICIPANTS

Site	Insurance Plan					
	Free	25	50	95	Individual Deductible	Total
Dayton, Ohio	295	237	270	263	94	1059
Seattle, Wash.	415	228	0	196	254	1093
Fitchburg, Mass.	226	119	55	105	164	669
Franklin Co., Mass.	285	149	56	144	201	840
Total	1221	733	281	708	718	3661

NOTE: The table excludes babies born into or adopted into enrolled families after initial family enrollment; insurance plan refers to medical coinsurance rates, or the Individual Deductible Plan.

physician, dentist, chiropractor) was determined from provider data collected by the HIE. Excluded procedures are given in Table 6.2; excluded providers are listed in Table 6.3. Drugs related to mental health diagnoses were also excluded. Table 6.4 lists those diagnoses.

We have also excluded pregnancy care from our analysis. A procedure was defined as pregnancy-related if its CRVS code or its related HICDA diagnoses codes fell into the ranges listed in Table 6.5.

Database Creation

The basic unit in our outpatient analysis data is a visit. For inpatient analysis, the basic unit is a hospital admission.[15]

California Relative Value Studies, published in 1975 by the California Medical Association.

[14]Commission on Professional Hospital Activities, *Hospital Adaptation of the ICDA (International Classification of Diseases Adapted for Use in the United States)*, 2d ed. (H-ICDA-2), CPHA, Ann Arbor, Mich., September 1973.

[15]Costs associated with repeated visits to the hospital by the patient's own physician are included in the total charges for the given hospital stay.

Table 6.2

EXCLUDED PROCEDURES

CRVS Code	HICDA Code	Description
90800-90899		Psychiatric services
99032-99034		Counseling (only if psychiatric provider)
92001-92014		Ophthalmologic services
92550-92557		Audiologic function tests
92559-92566		
	Y01.0,	Vision exam,
	370.0-370.9	refractive errors
	290-319	Mental disorders
	770.6	Hallucinations
	792.6	Nervousness
	Y00.2,Y12.6	Psychiatric examinations
	Y19.4	Counseling
	Y85.0-Y85.9	Inadequate social environment
	97.3-97.5	Shock therapy, psychotherapy
	E958	Suicide and self-inflicted injury

Table 6.3

EXCLUDED PROVIDERS

Dentists, dental clinics	Psychiatrists, psychiatric clinics
Chiropractors	Mental health clinics
Christian Science	Alcoholism treatment clinics
Podiatrists	Neuropsychiatry
Ophthalmologists	Psychologist, psychiatric nurse
Eye clinics	MSW, alcohol and drug abuse counselor
Optometrists, opticians	Psychologically oriented providers
Optical companies	

Table 6.4

DIAGNOSES DEFINING MENTAL-HEALTH-RELATED DRUGS

HICDA Code	Description
290-319	Mental disorders
770.6	Hallucinations
792.6	Nervousness
Y00.2,Y12.6	Psychiatric examinations
Y19.4	Counseling
Y85.0-Y85.9	Inadequate social environment
97.3-97.5	Shock therapy, psychotherapy
E958	Suicide and self-inflicted injury

Table 6.5

CODES DEFINING PREGNANCY-RELATED PROCEDURES

CRVS	Description	HICDA	Description
59000-59889	Fetal evaluation, excision, delivery, antepartum and postpartum care, abortion	Y06-Y07.1	Antepartum, postpartum care
		Y40-Y48.9	Perinatal morbidity, mortality
		Y30-Y32.9	Fetal deaths
		Y20-Y29.9	Hospital/nonhospital births
		72-75.9	Obstetrical procedures,
		631-678.9	Pregnancy complications, abortion, delivery

NOTE: If the reason for visit code had a value of 9050, the procedure was counted as pregnancy-related. Reason-for-visit codes were coded from the National Ambulatory Medical Care Survey: Symptom Classification (NAMCS), May 1974.

Among outpatient visits, we count only those visits that involve a face-to-face contact between a health provider and a patient, and that have a positive dollar charge.[16] We define a visit as a unique person/

[16]Most zero-charge visits are pre- or postoperative or pre- or postnatal. The expenditures for such visits are captured in the cost of the hospital admission. Claims data do not provide reliable data on the number of visits covered by a lump sum fee, as is often the case with surgery. To avoid problems with missing data, we deleted such zero cost

provider/date-of-service. For a given visit, we assembled all the elements associated with that visit: procedures performed, independent lab tests ordered, injections given, prescribed drugs, and so on. If a doctor sends his patient to the laboratory or radiologist in the same medical building and the pathologist or radiologist bills the patient directly (rather than through the physician), then the claims data will show two visits instead of one. Our definition of a face-to-face visit, described in Table 6.6, is an attempt to identify the actual visit rather than "billing" visits for ancillary services. These ancillary services, also described in Table 6.6, are largely visits where only radiology, anesthesiology, or pathology (RAP) was provided; that is, the visit had no CRVS code in the face-to-face range, only codes for RAP procedures.

We linked these ancillary services back to the face-to-face visit that most likely ordered the lab tests or anesthesia services. Among outpatient data, unfortunately, not all the services associated with a visit carry the same identifiers of person ID, date of service, and provider ID; for example, if a doctor orders an outside lab test as a result of an office visit, the charge for that lab test carries the identifiers of the lab performing the test. Therefore, we had to run all RAP-only procedures through a set of matching algorithms based on dates and provider IDs to link those tests with the appropriate office visit record. Office visit records represent the charge for the basic office visit apart from any procedures performed during the visit; they are defined in Table 6.7. We then had a staff physician check the quality of the matches by hand, revising those where an incorrect match had been made. The date/provider matching rules for RAP procedures are presented in Table 6.8.

Similarly, drug charges do not necessarily link directly to the visit which prescribed them. Purchased drug records were linked back to prescription records which carry the date and provider for the associated office visit plus the relevant diagnoses. If a match could not be made with prescription records, we then tried to find a match

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and courtesy visits. We could more accurately describe the visits measures as ambulatory-billed visits.

Table 6.6

CRVS CODES FOR RAP PROCEDURES AND FACE-TO-FACE VISITS

CRVS	Description
RAP	
70000-79999	Radiology, nuclear medicine
80000-89999	Pathology
any procedure where CRVS modifier is 30-49	Anesthesia
FACE-TO-FACE	
10000-62273	surgery
62280-64099	surgery
64531-69999	surgery
79000-79499	therapeutic radiation
90000-90099	office visit
90100-90199	home visits
90500-90599	emergency care services
90600-90699	consultations
90700-90749	immunizations, therapeutic injections
90750-90799	pediatric office visits
90800-90899	psychiatric services
90962-90999	dialysis services
91000-91299	GI diagnostic services
92000-92499	eye services
92504-92549	selected ENT services
93015-93017	selected cardiovascular services
93019-93022	selected cardiovascular services
93046	selected cardiovascular services
93500-93599	cardiac catherizations
95000-95199	allergy testing
96000-96300	specific therapeutic procedures
96450-96499	specific therapeutic procedures
96900-96920	specific therapeutic procedures
97000-97261	physical medicine visits
97500-97799	miscellaneous physical medicine
99032-99034	counseling, conference

Table 6.7

CRVS CODES DEFINING OFFICE VISIT RECORD

CRVS	Description
90000-90199	Office visits
90500-90599	Emergency care facility
90600-90699	Consultations
90750-90799	Infant and child care
90800-90899	Psychiatric services
97000-97261, 97500-97999	Physical medicine
99032-99034	Conference with patient
10000-62273, 62280-64099, 64531-69999	Surgery

NOTE: If either modifier for the CRVS code is anesthesia, then the record was *not* classified as an office visit record.

among office visit records. Date, provider, and drug code rules were devised to match purchase records to prescription records and office visit records. Again the poorer-quality matches were checked by hand. The matching rules for drug charges appear in Table 6.9.

Defining Preventive and Nonpreventive Visits

Once all the elements of a given visit were assembled, each procedure was classified as preventive or nonpreventive.[17] Preventive and nonpreventive are identified through checks for preventive diagnoses (e.g., gynecological exam), for CRVS codes for preventive procedures (e.g., Pap smears), or for well-care treatment history codes (applicable only to office visit records). Table 6.10 presents the specific CRVS procedure and HICDA diagnosis codes used to determine whether a procedure is classified as preventive.[18] Procedures such as Pap smears

[17]Hospitalizations and drug records were always classified as nonpreventive. Office visit records could be classified as both preventive and nonpreventive depending on what services and diagnoses were present for that visit.

[18]Bonnie Scott, M.D., provided valuable assistance in devising rules for identifying preventive care.

Table 6.8

RAP MATCHING RULES

Quality of Match	Provider/Date Rule
1 (Best)	Same date of service for lab test and visit
2	Same provider for lab test and visit AND date of lab test within 2 weeks after date of visit
3	Referring provider for lab test equals the provider for the visit AND date of lab test within 2 weeks after date of basic visit
4	Date of lab test within 2 weeks after date of visit
5	Same provider for lab test and visit AND date of lab test 2 weeks or less before date of visit
6	For PAP SMEARS ONLY: Referring provider for lab test equals the provider for the visit AND date of lab test 2 weeks or less before date of visit For NON-PAP SMEARS ONLY: Referring provider for lab test equals the provider for the visit AND date of lab test 7 days or less before date of basic visit
7	For PAP SMEARS ONLY: Date of lab test 2 weeks or less before date of visit For NON-PAP SMEARS ONLY: Date of lab test 7 days or less before date of visit
8	Referring provider for lab test equals the provider for the visit AND date of lab test between 15 and 90 days after date of visit
9	Date of lab test between 15 and 90 days after date of visit
10 (poorest)	For PAP SMEARS ONLY: Date of lab test between 15 and 90 days before date of visit

Table 6.9

DRUG MATCHING RULES

Match Level	Purchase Record	Prescription Record	Office Visit Record
1	Prescription date	= Date of service	
	Prescriber	= Provider	
	NDC code	= NDC code	
2	Prescription date	= Date of service+1-2 days	
	Prescriber	= Provider	
	NDC code	= NDC code	
3	Prescription date	= Date of service+3-14 days	
	Prescriber	= Provider	
	NDC code	= NDC code	
4	Prescription date	= Date of service	
	NDC code	= NDC code	
5	Prescription date	= Date of service+1-2 days	
	NDC code	= NDC code	
6	Prescription date	= Date of service+3-14 days	
	NDC code	= NDC code	
7-12	Same as 1-6 except use therapeutic code instead of the NDC code for matching		
13	Prescription date		= Date of service
	Prescriber		= Provider
14	Prescription date		= Date of service+1-2 days
	Prescriber		= Provider
15	Prescription date		= Date of service+3-14 days
	Prescriber		= Provider

NDC = National Drug Code from the *National Drug Code Directory*, published by the Public Health Services, U.S. Department of Health and Human Resources.

and tuberculosis tests were not defined as preventive if cervical cancer or tuberculosis, respectively, was diagnosed earlier or suspected when the procedure was performed. A visit is considered preventive if it contains an element of evaluation or treatment that is classified as preventive.

Table 6.10

CODES DEFINING PREVENTIVE PROCEDURE

CRVS Code	Description	HICDA Code	Description
86580, 86585	Tuberculosis tests	Y00.0	Administrative exam
88150, 88151	Pap smears	Y00.1	General medical exam
90088	Annual physical	Y01.3	Gyn exam
90700-90729	Immunizations	Y80.0-Y80.9	Screening exams
90751-90764	Well child care	Y81.0-Y81.8	Immunizations
99090, 99095	Multiphasic exams		
90000-90087	Office visit but *only* if listed as well care visit		

Once the preventive/nonpreventive nature of the service was established, the service was assigned to specific preventive or nonpreventive categories. For preventive services, the basic categories were immunizations, cancer screens, other screening exams, and physical exams; the counterparts for nonpreventive services were diseases preventible by immunization, cancers, conditions detected by other screening exams, and conditions detected by general physical exams.[19] Specific preventive (or target) categories were based on procedure codes and diagnosis codes that indicate types of exams; specific nonpreventive (or target) categories were assigned on the basis of diagnoses.[20] Nonpreventive services with related diagnoses not in the "preventive

[19]This fourth category also includes those services classified as preventive but which do not fall into one of the first three categories.

[20]Specific preventive services could be assigned to one target

targeted" category list were assigned to a fifth category: all remaining conditions. If a service classified as preventive was related to one of the specific *nonpreventive* diagnoses, e.g., cervical cancer, the service was reclassified to nonpreventive and assigned to one of the nonpreventive categories. Table 6.11 shows the CRVS procedure and HICDA diagnosis codes related to each of the four specific preventive categories. Table 6.12 displays the HICDA diagnosis codes used to assign the nonpreventive categories.

Apportionment of Costs

Each record contains the amount charged for that service. That amount is apportioned among categories depending on the number of related diagnoses. Each related diagnosis is assigned to either a preventive target category or a nonpreventive category.[21] A service, then, may be assigned to more than one category and the cost needs to be apportioned accordingly. If the service was an office visit record, all diagnoses on the record were assumed to be relevant. In addition, office visit records may have been assigned additional preventive target categories if the office visit record itself did *not* contain a preventive target category that appeared among the procedures associated with the visit. The office visit charge would be split among all the categories associated with the entire visit, not just those appearing on the office visit record itself.

Two apportionment schemes were used: one for procedures and one for office visit records. For procedure records associated with the visit, the cost was simply prorated among the number of relevant

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category only. Nonpreventive services could be assigned to more than one target category if there were more than one related diagnosis and the diagnoses fell into different categories. However, general procedures, such as those with CRVS codes for office visits and physical exams, may have more than one related diagnosis. An office visit could have a diagnosis code for a gynecological exam and a diagnosis code for an immunization, for example. In that case, two *different* types of preventive activities were performed and the office visit charge would be split between the two preventive categories.

[21]If the CRVS code for the service fell into one of the preventive categories and the given related diagnosis was not among those in the nonpreventive category list, the diagnosis was assigned to the preventive category linked to the CRVS code.

Table 6.11

CODES ASSIGNING SPECIFIC PREVENTIVE CATEGORIES

Activity Category	CRVS	HICDA	General Description
IMMUNIZATIONS			
	90710, 90720-90723	Y81.0-Y81.8	DPT, polio, mumps, smallpox, measles, rubella, typhoid, flu, pneumonia
CANCER SCREENS			
	40200-40267,71000, 71010,71020,71030, 71034,76090-76093, 76300,88150,88151, 89205,90062,90063, 90064	Y01.3, Y80.0 Y02.2	Colonoscopy, proctoscopy, chest X-rays, mammography, thermography, pap smear, stool guaiac, breast and pelvic exams, rectal exams, gyn exams, cancer screening
OTHER SCREENS			
	80106-80119,81000, 81001-81005, 81015,81016,82250, 82258,82465,82475, 82565,82566,82947-82951,82980,83533-83539,83705,84075, 84132, 84251,84450,84460, 84475,84550-84555, 85007,85014,85018, 85021-85026,85031-85034,85048,85650, 86082,86580,86585, 87081,87086,87087, 89005-89007,93000-93023,99007,99008, 99018,99080	Y80.1-Y80.9	Multichannel tests, urinanalysis, blood and urine sugar, selected blood tests (hematocrit, CBC, etc.), serum cholesterol, TB test, bacterial cultures, kidney function tests, uric acid, blood thyroid tests, liver function tests, electrocardiograms
PHYSICAL EXAM[a] (and all remaining unassigned preventive)	89998,90088,90751-90764,99090,99095, 90030-90034, 90000-90087[b]	Y00.0, Y00.1	Well-care visits, multiphasic screens, general medical exams, administrative exams

[a]A procedure fell into this final category if it was classified as preventive and had not already been assigned to one of the first three (and more specific) categories.

[b]CRVS codes 90000-90087 are considered preventive *only* if the visit was described as well care.

Table 6.12

CODES ASSIGNING SPECIFIC NONPREVENTIVE CATEGORIES
PREVENTIVE TARGETED SERVICES

Condition Category	HICDA Codes	Description
IMMUNIZABLE DISEASES		
	001,032,033-033.9, 037,040-044,055, 056-056.9,470-480	Typhoid, diphtheria, pertussis, tetanus, polio, measles, rubella, pneumonia and influenza
CANCERS		
	153-154.2,159,162.1, 174-174.2,180-180.9, 185,620-621.3	Rectal, stomach, lung, breast, cervical, and prostate cancers, chronic cervicitis, leukoplakia, dysplasia, hyperplasia and chronic erosion and ulceration of the cervix are treated as precancerous conditions
DETECTED BY SCREENS		
	Y72.0,Y71.8,Y73.0, Y74.7,Y72.1, 011-019.9,204-207.9, 242-244.9,250-250.9, 272-272.9,274, 302-303.9,313-313.9, 400,401,402,403-403.9, 410-413,414,415-438.9, 571.0,571.2-571.9, 577,577.1,580-599.9, 634.5,774-774.9	Abnormal blood serum, proteinuria, urine casts, tuberculosis, leukemia, hyperthyroidism, diabetes, hyperlipidemia, gout, alchoholism, hypertension, heart disease, cirrhosis, pancreatic diseases, kidney disease, chest pain, heart murmur
DETECTED BY GENERAL EXAM		
	140-149.9,172-173.9, 277,454-455.9,530.5, 531-535.9,691,692-692.9,698.3	Mouth and throat cancers, melanoma, obesity, varicose veins, hemorrhoids, reflux esophagitis, ulcers, skin conditions

diagnoses; if there were two related diagnoses (each of which was assigned to a target category), the cost was split equally between the two. For office visit records, the same process was used, except when preventive target categories were added to an office visit record that originally had *both* preventive and nonpreventive categories. In that instance, the process was not equal division of cost among categories. Nonpreventive target categories were assigned a prorated share based on the original number of preventive and nonpreventive target categories. For example, if there were three original categories, two nonpreventive and one preventive, the nonpreventive categories received two-thirds of the cost. The remaining cost not assigned to nonpreventive would be split equally among the preventive categories. Following the previous example, if one preventive category had been added, the remaining one-third of the cost would be split between the two preventive categories giving each one-sixth of the original total cost.

Aggregation

Once each element of a visit had been assigned to preventive and/or nonpreventive target categories and its cost apportioned among those categories, the data were aggregated to the visit level. Preventive and nonpreventive category costs were summed over all visit procedures and indicators were created for each category present in the visit. Visit-level data were then aggregated to an annual level and finally to a person level. In the end, we had four main analysis files: (1) a highly detailed service-level file with procedures and drugs associated with a visit and their related diagnoses codes, (2) a visit-level file with flags and costs for the types of preventive and nonpreventive targeted activities occurring in a given visit, (3) an annual-level file with three records per person containing counts and costs for the different types of activities experienced in each year, and (4) a person-level file with one record per person containing three-year totals for preventive and nonpreventive category counts and costs.

Demographic data

To each of these files we added demographic data consisting of information on sex, age, race, income, education, family size, various health status measures at the beginning of the survey, and type of insurance coverage. Missing demographic data had to be dealt with, since these data would provide our basic list of covariates. For income-related variables, imputed values were used to replace missing data; for family-related variables, either the family mean or the value belonging to the head of the household was used depending on the variable in question.

REGRESSION VARIABLES

Dependent Variables

Use of Inpatient Services. We measured use of inpatient services both by a count of admissions in each year and by the associated hospital and physician inpatient expenditures for each admission. Cost per admission is expressed in 1967 dollars and is converted to its natural logarithm for analysis.

Use of Nonpreventive Outpatient Services. We measured nonpreventive outpatient services both by a count of all nonpreventive services in each year and by the associated expenditure for each visit. Cost per visit is expressed in 1967 dollars and is converted to its natural logarithm for analysis.

Use of Nonpreventive Outpatient Services Associated with Preventive Services. These nonpreventive services, termed preventive targeted, are those associated with outcomes that are intended to be prevented, diminished in severity, or detected early by our designated preventive medical services (see Table 6.12). This measure is designed to remove sources of visits and costs that are not expected to be affected by the use of preventive services. That is, we have attempted to remove the irrelevant "noise" from variations in the use of nonpreventive medical services. As with the other services, this set is measured both by a count of nonpreventive services in each year and by the associated expenditure for each visit. Cost per visit is expressed in 1967 dollars and is converted to its natural logarithm for analysis.

Change in Health Status. We measured change in health status as the difference between the person's General Health Index (GHINDX) at the end of the third year of the HIE and his/her GHINDX value at enrollment. The General Health Index is defined below.

Independent Variables

Receipt of Exogenous Physical Examination. A physical examination was randomly assigned at the beginning of the HIE to approximately two-thirds of the HIE sample population. It was approximately comparable to an "executive physical" exam, but with certain limitations: Most particularly, it did not include inoculations against contagious disease, Pap smears, or testicular, cervical, or rectal examinations.

Preventive Care Measures. We analyzed the effects of receiving preventive measures, including any disease-specific measures as well as any patient- or physician-initiated annual physical, administrative exam, multiphasic exam, or well-child visit. Disease-specific preventive measures include patient- or physician-initiated immunizations and specific screening exams and procedures for conditions such as cancer, diabetes, kidney and liver disorders, and cardiovascular problems[22] (see Table 6.11). Preventive care measures constructed for this analysis include:

- Indicators for having had preventive care in the previous years of the study;
- The average annual number of preventive visits during the study; and
- The deviation of a person's number of preventive visits in a given year from his annual average.

Insurance Plan Variables. We have used four dummy variables to represent the insurance plans, one for each of the coinsurance levels (25, 50 and 95 percent) and the individual deductible plan. The free care plan is used as the basis for comparison.

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[22]Pap smears and tuberculosis tests were not considered preventive if cervical cancer or tuberculosis, respectively, was diagnosed earlier or suspected.

Measure of Health Status. We used a measure of general health status at enrollment to predict use of services. This measure is based on the self-administered Medical History Questionnaire for persons aged 14 years or older. The measure for children is based on questionnaires filled out by parents. All of the data on the health measure used in this report were collected at the beginning of the study or after three years of participation.

The General Health Index (GHINDX) for adults (aged 14 and older) is based on 22 questionnaire items measuring perceptions of health at the present, in the past, and in the future; the items also measure resistance to illness and health worry. GHINDX items refer to health in general and do not specify a particular component of health. The construct is a subjective assessment of personal health status. The reliability and validity of the General Health Index have been extensively studied and documented (Ware, 1976; Davies and Ware, 1981).[23] A similar scale has been constructed for children based on twelve items (Eisen et al., 1980).

Other Covariates. The model used in our analysis also included covariates for other experimental treatments, age, gender, race, family income, and family size. With the exception of family size and income, the data were collected before or during enrollment in the study. These other covariates plus those already described are given in Table 6.13.

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[23]Because the Medical History Questionnaire was not administered at enrollment in Dayton, the enrollment value of GHINDX is missing for Dayton enrollees. We replaced that missing value with an imputed value using coefficients from a side regression of GHINDX on nonexperimental variables and the responses to questions about health (e.g., excellent/good/fair/poor), pain, and worry.

Table 6.13

INDEPENDENT VARIABLES

TREATMENT VARIABLES

Indicator Variables

P25	= 1	if coinsurance rate is 25 percent[a]
P50	= 1	if coinsurance rate is 50 percent
P95	= 1	if coinsurance rate is 95 percent
IDP	= 1	if Individual Deductible Plan
ADLTIDP	= 1	if adult (age ≥ 18) and on Individual Deductible Plan
ADLTPAY	= 1	if adult (age ≥ 18) and coinsurance > 0 (pay plans)
TOOKPHYS	= 1	if received physical exam at enrollment[b]
TOOKPHY1	= 1	if TOOKPHYS = 1 and first year of study
TOOKPHY2	= 1	if TOOKPHYS = 1 and second year of study
TOOKPHY3	= 1	if TOOKPHYS = 1 and third year of study
TERM3	= 1	if enrolled for 3 years[c]
WKLYHR	= 1	if filed health diary weekly[d]
NOHR	= 1	if not asked to file health diary

SOCIODEMOGRAPHIC VARIABLES

Indicator Variables

CHILD	= 1	if age < 18[e]
ADULT2	= 1	if age ≥ 40
FCHILD	= 1	if female aged 17 or less
FAD1	= 1	if female aged 18 to 39 years
FAD2	= 1	if female aged 40 or more years
BLACK	= 1	if person is black
TWOHEAD	= 1	if household has two heads of household
AFDC	= 1	if household receives welfare (Aid to Families with Dependent Children)
SEA	= 1	if enrolled in Seattle, Wash.[f]
FIT	= 1	if enrolled in Fitchburg, Mass.
FRA	= 1	if enrolled in Franklin County, Mass.
YEAR1	= 1	if year 1 of study
YEAR2	= 1	if year 2 of study
YEAR3	= 1	if year 3 of study
MISINC	= 1	if family income was missing
MISAFDC	= 1	if AFDC was missing

Continuous Variables

LNINC	=	natural logarithm of 75-76 family income[g]
LFAM	=	natural logarithm of family size
AGE	=	age at enrollment
LNAGE	=	natural logarithm of age at enrollment

Table 6.13--continued

HEALTH STATUS VARIABLES

Indicator Variables

FORM1 = 1 if infant form of health care questionnaire[h]
FORM2 = 1 if pediatric form of health care questionnaire
FORM12 = 1 if changed from infant to pediatric form during the 3 years
FORM23 = 1 if changed from pediatric to adult form during the 3 years

GHINMIS = 1 if GHINDX at enrollment missing

Continuous Variables

GHINDX = general health index
GHI2 = square of general health index
GHI_GHMS = GHINDX * GHINMIS[i]
GH2_GHMS = GHI2 * GHINMIS

SELF-PREVENTION VARIABLES

Indicator Variables

HADPREV = 1 if had at least one preventive visit during the 3 years

Continuous Variables

PBAR = average number of preventive visits per year
P1_PBAR = (deviation of number of preventive visits in year 1 from PBAR) * YEAR2
P2_PBAR = (deviation of number of preventive visits in year 2 from PBAR) * YEAR3

NOTE: Indicator values = 0 or 1.

[a]Free plan is the omitted group.

[b]No examination is the omitted group.

[c]Five-year enrollment is the omitted group.

[d]Filing biweekly is the omitted group.

[e]Male aged 18-39 is the omitted group.

[f]Dayton, Ohio, is the omitted group.

[g]Income is set equal to $1000, if reported to be less. Converted to 1967 constant U.S. dollars to remove intersite differences in the cost of living.

[h]Adult form is the omitted group.

[i]GHI_GHMS is nonzero only for those individuals who had a missing GHINDX score. The value of GHI_GHMS, then, is the imputed value assigned to the individual; the value is zero for those who had actual GHINDX scores.

VII. USE OF SPECIFIC PREVENTIVE PROCEDURES

The following tables elaborate on the results summarized in Sec. III. The tables are divided into two major groups. Tables 7.1 through 7.10 document the frequencies of use of preventive medical services for children; Tables 7.11 through 7.31 do so for adults. Tables 7.32 through 7.34 document inputs used to calculate the cost to bring preventive care up to standard. Within each group, tables containing frequencies by age-sex group are followed by those giving frequencies by type of insurance coverage. The former list the probability of obtaining a procedure and the average number of visits in which the procedure was obtained, both per year and over the three-year study period. The insurance tables compare those same variables for each procedure for the subsamples on the free plan (no cost-sharing), on the household pay plans, and on the individual deductible plan, in which only inpatient care was free.

The order of presentation thus roughly follows the discussion in Sec. III. The first tables demonstrate the relatively low levels of immunization among children, along with the small increase in immunization rates just prior to school enrollment. The difference in rates of adult male and female use of preventive care can be observed, for instance, by comparing Tables 7.12 with 7.13. The insurance tables (7.20-7.23, for example) show that adults on the individual deductible plan had less use than did those on the pay plans (relative to those on the free plan). They also show the differences in plan effects between people aged 17-45 and those aged 45-65.

Table 7.1

PREVENTIVE VISITS AND VACCINATIONS FOR NEWBORNS IN FIRST 18 MONTHS

No. of Preventive Visits	Percent of Sample	No. of Vaccinations	Percent of Sample				
			DPT	Polio	Measles/ Mumps	Rubella	TB-Test
0	7	0	24	23	39	39	54
1	5	1	13	12	54	52	35
2	1	2	19	14	7	8	11
3	6	3	24	28	0	1	0
4	2	4	20	16	0	0	0
5	10	5	1	1	0	0	0
6	14						
7	16		100	100	100	100	100
8	18						
9	16						
10	3						

NOTE: Sample size for all newborn-baby tables = 97.

Table 7.2

AVERAGE NUMBER OF VISITS FOR GIVEN TYPE OF PREVENTIVE CARE BY PLAN: NEWBORNS, FIRST 18 MONTHS

Preventive Care	Plan	Plan	Plan
Any well care	6.53	5.98	5.33
DPT	2.08	2.31	1.39
Polio	2.05	2.24	1.11
MMR[a]	0.737	0.732	0.44
TB-Test	0.684	0.585	0.33
Sample size	38	41	18

[a]Measles/mumps/rubella.

Table 7.3

AVERAGE NUMBER OF VISITS FOR GIVEN TYPE OF PREVENTIVE CARE: CHILDREN AGED 0-7, BY ONE-YEAR AGE INTERVALS

Age Interval	Any Preventive	DPT	Polio	MMR[a]	TB-Test	Sample Size
0-1	4.20	1.58	1.50	0.015	0.27	131
1-2	1.63	0.50	0.47	0.55	0.21	130
2-3	0.69	0.06	0.06	0.03	0.18	140
3-4	0.61	0.05	0.05	0.02	0.18	132
4-5	0.65	0.17	0.16	0.05	0.17	145
5-6	0.62	0.27	0.28	0.09	0.21	172
6-7	0.40	0.05	0.06	0.01	0.08	172

[a]Measles/mumps/rubella.

Table 7.4

AVERAGE NUMBER OF VISITS FOR GIVEN TYPE OF PREVENTIVE CARE: CHILDREN AGED 0-7, BY TWO-YEAR AGE INTERVALS

Age Interval	Any Preventive	DPT	Polio	MMR[a]	TB-Test	Sample Size
0-2	5.86	2.19	2.14	0.63	0.51	63
1-3	2.15	0.52	0.49	0.55	0.36	67
2-4	1.48	0.11	0.10	0.04	0.45	73
3-5	1.29	0.24	0.25	0.07	0.32	59
4-6	1.24	0.48	0.48	0.15	0.34	86
5-7	1.00	0.28	0.30	0.07	0.31	86

[a]Measles/mumps/rubella.

Table 7.5

PREVENTIVE-CARE USE FOR CHILDREN IN THREE-YEAR PERIOD
(Means and standard errors)

Preventive Procedure	Probability of Any in 3 Years	Number of Visits per 3 Years per Enrollee	Number of Visits per 3 Years per User
Children Aged 0-6 (Sample Size = 689)			
Any immunization	.5269 (.022)	1.1248 (.0639)	2.1351 (.079)
Any preventive care	.7765 (.0187)	2.4804 (.0997)	3.1944 (.0969)
Children Aged 7-16 (Sample Size = 803)			
Any immunization	.2055 (.0187)	.2528 (.0252)	1.2303 (.0494)
Any preventive care	.6015 (.0209)	1.0324 (.0518)	1.7164 (.0547)

Table 7.6

PREVENTIVE-CARE USE FOR CHILDREN PER YEAR
(Means and standard errors)

Preventive Procedure	Probability of Any in One Year	Number of Visits per Year per Enrollee	Number of Visits per Year per User
Children Aged 0-6 (Sample Size = 1580 Person/Years)			
Any immunization	.2854 (.0136)	.4779 (.0279)	1.6741 (.0469)
Any preventive care	.5560 (.0186)	1.0253 (.0445)	1.8409 (.0528)
Children Aged 7-16 (Sample Size = 2699 Person/Years)			
Any immunization	.07670 (.00711)	.08262 (.00788)	1.0773 (.0323)
Any preventive care	.2972 (.0133)	.3401 (.0164)	1.1446 (.0164)

Table 7.7

AVERAGE PREVENTIVE-CARE USE FOR THREE-YEAR TOTAL BY PLAN: CHILDREN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Children, Aged 0-6		
Probability of any	.8252 (.02898)	.7372 (.030)	-2.11	.7786 (.0389)	-0.96
Visits per enrollee	2.7805 (.1688)	2.3846 (.1523)	-1.74	2.145 (.2017)	-2.42
Visits per user	3.3695 (.1574)	3.2348 (.1511)	-0.62	2.7549 (.2029)	-2.39
Sample size of enrollees (persons)	246	312		89	
			Children, Aged 7-16		
Probability of any	.64773 (.0357)	.5960 (.0304)	-1.10	.5315 (.0477)	-1.95
Visits per enrollee	1.1705 (.0956)	1.0051 (.0724)	-1.38	.8532 (.1095)	-2.18
Visits per user	1.807 (.0932)	1.6864 (.0791)	-0.99	1.6053 (.1224)	-2.39
Sample size of enrollees (persons)	264	396		143	

Table 7.8

AVERAGE IMMUNIZATION USE FOR THREE-YEAR TOTAL BY PLAN: CHILDREN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Children, Aged 0-6		
Probability of any	.5894 (.0362)	.4872 (.0331)	-2.09	.50382 (.0493)	-1.40
Visits per enrollee	1.2846 (.1065)	1.1314 (.1024)	-1.04	.80916 (.1104)	-3.10
Visits per user	2.1793 (.1139)	2.3224 (.1326)	-0.82	1.6061 (.1576)	-2.95
Sample size of enrollees (persons)	246	312		89	
			Children, Aged 7-16		
Probability of any	.2121 (.0319)	.2172 (.0278)	0.12	.16084 (.0404)	-1.00
Visits per enrollee	.2500 (.0393)	.2828 (.0403)	0.58	.1748 (.0469)	-1.23
Visits per user	1.1786 (.0539)	1.3023 (.0862)	-1.22	1.087 (.0495)	-1.25
Sample size of enrollees (persons)	264	396		143	

Table 7.9

AVERAGE PREVENTIVE-CARE USE FOR ANY YEAR TOTAL BY PLAN: CHILDREN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Children, Aged 0-6		
Probability of any	.6049 (.0294)	.5319 (.0295)	-1.75	.5256 (.0386)	-1.64
Visits per enrollee	1.139 (.0751)	.9819 (.0679)	-1.55	.9113 (.0914)	-1.93
Visits per user	1.883 (.0884)	1.846 (.0809)	-0.31	1.7338 (.109)	-2.95
Sample size of enrollees (person/years)	567	720		293	
			Children, Aged 7-16		
Probability of any	.3434 (.0244)	.2822 (.01776)	-2.03	.2531 (.0318)	-2.26
Visits per enrollee	.3895 (.0303)	.3291 (.0229)	-1.59	.2798 (.0346)	-2.38
Visits per user	1.134 (.0222)	1.1662 (.0275)	0.91	1.1057 (.0346)	-0.69
Sample size of enrollees (person/years)	891	1322		486	

Table 7.10

AVERAGE IMMUNIZATION USE FOR ANY YEAR TOTAL BY PLAN: CHILDREN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
		Children, Aged 0-6			
Probability of any	.3245 (.0232)	.2667 (.0207)	-1.86	.2560 (.0275)	-1.91
Visits per enrollee	.5503 (.0475)	.4722 (.0443)	-1.20	.3515 (.0482)	-2.94
Visits per user	1.696 (.0706)	1.771 (.0718)	0.75	1.3733 (.112)	-2.43
Sample size of enrollees (person/years)	567	720		293	
		Children, Aged 7-16			
Probability of any	.07632 (.0113)	.08396 (.0112)	0.48	.05761 (.0142)	-1.03
Visits per enrollee	.7856 (.0118)	.9455 (.0129)	0.91	.05761 (.0142)	-1.13
Visits per user	1.0294 (.0199)	1.1261 (.0592)	1.55	1.000 (.000)	-1.48
Sample size of enrollees (person/years)	891	1322		486	

Table 7.11

PREVENTIVE-CARE USE FOR ADULTS IN THREE-YEAR PERIOD
(Means and standard errors)

Preventive Procedure	Probability of Any in 3 Years	Number of Visits per 3 Years per Enrollee	Number of Visits per 3 Years per User
Adults Aged 17-44 (Sample Size = 1697)			
Immunizations			
Any	.05245	.07307	1.3933
	(.00578)	(.0105)	(.104)
Flu	.0165	.02711	1.6429
	(.00359)	(.0075)	(.206)
Tetanus	.01414	.01591	1.125
	(.00309)	(.00383)	(.0675)
Other			
Blood tests (non-CBC)	.0548	.05834	1.0645
	(.0057)	(.00619)	(.0255)
EKG	.03477	.03771	1.0847
	(.00473)	(.00529)	(.0359)
Adults Aged 45-65 (Sample Size = 579)			
Immunizations			
Any	.10535	.1762	1.6721
	(.0140)	(.0285)	(.1564)
Flu	.07599	.1399	1.841
	(.0123)	(.0271)	(.2044)
Tetanus	.01036	.01036	1.000
	(.0042)	(.0042)	(.0000)
Other			
Blood tests (non-CBC)	.11572	.13126	1.1343
	(.0139)	(.0168)	(.0554)
EKG	.08083	(.1036	1.1764
	(.0117)	(.0151)	(.0718)

Table 7.12

PREVENTIVE-CARE USE FOR MALES IN THREE-YEAR PERIOD
(Means and standard errors)

Preventive Procedure	Probability of Any in 3 Years	Number of Visits per 3 Years per Enrollee	Number of Visits per 3 Years per User
Males Aged 17-44 (Sample Size = 819)			
Any preventive care	.23199 (.0148)	.3504 (.0274)	1.5105 (.0662)
Sigmoidoscopy	.002442 (.00173)	.003663 (.00273)	1.500 (.354)
Chest X-ray	.04273 (.00702)	.04762 (.0082)	1.114 (.0538)
Complete blood count	.067155 (.00869)	.07326 (.0098)	1.0909 (.0388)
Males Aged 45-65 (Sample Size = 248)			
Any preventive care	.29839 (.0291)	.6452 (.0839)	2.1622 (.1863)
Sigmoidoscopy	.004032 (.00402)	.004032 (.00402)	1.000 (.000)
Chest X-ray	.06855 (.0161)	.08065 (.0199)	1.1765 (.0925)
Complete blood count	.06452 (.00156)	.07661 (.0196)	1.1875 (.0976)

Table 7.13

PREVENTIVE UTILIZATION FOR FEMALES IN THREE-YEAR PERIOD
(Means and standard errors)

Preventive Procedure	Probability of Any in 3 Years	Number of Visits per 3 Years per Enrollee	Number of Visits per 3 Years per User
Females Aged 17-44 (Sample Size = 878)			
Any preventive care	.7790 (.0141)	1.8303 (.0519)	2.3494 (.0508)
Sigmoidoscopy	.00278 (.00161)	.00278 (.00161)	1.000 (.000)
Chest X-ray	.03645 (.00632)	.03896 (.00716)	1.0937 (.0515)
Complete blood count	.1287 (.0114)	.1652 (.0166)	1.2832 (.0587)
Pap smears	.6560 (.0163)	1.231 (.0404)	1.8767 (.0400)
Pap smear or gyn exam	.7005 (.0157)	1.394 (.0428)	1.9902 (.0417)
Mammogram	.01139 (.00358)	.01139 (.00358)	1.000 (.000)
Females Aged 45-65 (Sample Size = 331)			
Any preventive care	.7009 (.0252)	1.7825 (.0980)	2.5431 (.1059)
Sigmoidoscopy	.006042 (.00426)	.00906 (.00674)	1.5000 (.3536)
Chest X-ray	.06344 (.0134)	.07553 (.0169)	1.1905 (.0857)
Complete blood count	.1480 (.0195)	.1813 (.0265)	1.2245 (.0778)
Pap smears	.56495 (.0273)	1.1329 (.0702)	2.0053 (.0780)
Pap smear or gyn exam	.5861 (.0271)	1.2085 (.0737)	2.0619 (.08203)
Mammogram	.02417 (.0084)	.02417 (.0084)	1.000 (.000)

Table 7.14

PREVENTIVE-CARE USE FOR ADULTS PER YEAR
(Means and standard errors)

Preventive Procedure	Probability of Any in One Year	Number of Visits per Year per Enrollee	Number of Visits per Year per User
Adults Aged 17-44 (Sample Size = 5091 Person/Years)			
Immunizations			
Any	.02082	.02436	1.1698
	(.00267)	(.00351)	(.0488)
Flu	.007464	.009036	1.2105
	(.00187)	(.0025)	(.0758)
Tetanus	.004714	.005304	1.125
	(.00103)	(.00128)	(.0675)
Other			
Blood tests (non-CBC)	.01925	.01945	1.0102
	(.00204)	(.00206)	(.0102)
EKG	.01257	.01257	1.000
	(.00176)	(.00176)	(.000)
Adults Aged 45-65 (Sample Size = 1737 Person/Years)			
Immunizations			
Any	.05066	.05872	1.1591
	(.00768)	(.00949)	(.0719)
Flu	.03972	.04663	1.1739
	(.00727)	(.00905)	(.0899)
Tetanus	.00345	.00345	1.000
	(.0014)	(.0014)	(.000)
Other			
Blood tests (non-CBC)	.0426	.04375	1.027
	(.00531)	(.00559)	(.0184)
EKG	.0339	.03454	1.0345
	(.00473)	(.00505)	(.0232)

Table 7.15

PREVENTIVE-CARE USE FOR MALES PER YEAR
(Means and standard errors)

Preventive Procedure	Probability of Any in One Year	Number of Visits per Year per Enrollee	Number of Visits per Year per User
Males Aged 17-44 (Sample Size = 2457 Person/Years)			
Any preventive care	.09686 (.00688)	.11681 (.00914)	1.2059 (.0345)
Sigmoidoscopy	.001221 (.000909)	.001221 (.000909)	1.000 (.000)
Chest X-ray	.015466 (.00263)	.015873 (.00272)	1.0263 (.0260)
Complete blood count	.02401 (.00321)	.02442 (.00328)	1.0169 (.0168)
Males Aged 45-65 (Sample Size = 744 Person/Years)			
Any preventive care	.15591 (.0174)	.21505 (.0279)	1.3793 (.0736)
Sigmoidoscopy	.001344 (.00134)	.001344 (.00134)	1.000 (.000)
Chest X-ray	.02688 (.00664)	.02688 (.00664)	1.000 (.000)
Complete blood count	.02554 (.00652)	.02554 (.00652)	1.000 (.000)

Table 7.16

PREVENTIVE-CARE USE FOR FEMALES PER YEAR
(Means and standard errors)

Preventive Procedure	Probability of Any in One Year	Number of Visits per Year per Enrollee	Number of Visits per Year per User
Females Aged 17-44 (Sample Size = 2634 Person/Years)			
Any preventive care	.4844 (.0118)	.6101 (.0173)	1.2594 (.0168)
Sigmoidoscopy	.000759 (.000536)	.000759 (.000536)	1.000 (.000)
Chest X-ray	.01291 (.0023)	.01329 (.00239)	1.0294 (.0290)
Complete blood count	.05239 (.00506)	.05505 (.00553)	1.0507 (.0206)
Pap smears	.3709 (.0115)	.4104 (.01347)	1.1064 (.0109)
Pap smear or gyn exam	.40812 (.0117)	.4647 (.0143)	1.1386 (.0120)
Mammogram	.003796 (.00119)	.003796 (.00119)	1.000 (.000)
Females Aged 45+ (Sample Size = 993 Person/Years)			
Any preventive care	.4391 (.0198)	.5942 (.0327)	1.3532 (.0365)
Sigmoidoscopy	.002014 (.00142)	.0030211 (.00225)	1.500 (.354)
Chest X-ray	.02518 (.00562)	.02518 (.00562)	1.000 (000)
Complete blood count	.05942 (.00857)	.06042 (.00884)	1.0169 (.01657)
Pap smears	.3313 (.0190)	.3776 (.0234)	1.1398 (.02187)
Pap smear or gyn exam	.3484 (.0194)	.4028 (.02456)	1.1561 (.0242)
Mammogram	.00806 (.0028)	.00806 (.00119)	1.000 (.000)

Table 7.17

NUMBER OF YEARS IN WHICH PREVENTIVE CARE WAS OBTAINED

Number of Years	Percent Obtaining Preventive Care			
	Males 17-44	Males 45+	Females 17-44	Females 45+
0	76.8[a]	70.2	22.1	29.9
1	18.2	17.3	29.7	26.2
2	4.2	8.1	28.9	27.0
3	0.9	4.4	19.2	17.8

[a]That is, 76.8 percent of males 17-44 received preventive care in none of the three years of the study; 18.2 percent in one of the three; and so on.

Table 7.18

NUMBER OF YEARS IN WHICH FLU OR PNEUMONIA IMMUNIZATIONS WERE OBTAINED

Number of Years	Percent Obtaining Immunizations			
	Males 17-44	Males 45+	Females 17-44	Females 45+
0	98.2	94.4	98.5	90.9
1	1.6	2.8	0.9	5.7
2	0.0	2.0	0.5	1.8
3	0.2	0.8	0.1	1.5

Table 7.19

NUMBER OF YEARS IN WHICH WOMEN OBTAINED PAP SMEARS OR GYNECOLOGICAL EXAMINATIONS

	Percent Obtaining			
	Pap Smear		Pap Smear or Gynecological Exam	
Number of Years	Age 17-44	Age 45+	Age 17-44	Age 45+
0	34.4	43.5	30.0	41.4
1	30.9	24.5	31.3	25.1
2	23.8	21.1	25.1	21.1
3	10.9	10.9	13.7	12.4

Table 7.20

AVERAGE IMMUNIZATION USE FOR THREE-YEAR TOTAL, BY PLAN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Adults Aged 17-44		
Probability of any	.0642 (.0108)	.0537 (.0089)	-0.75	.0313 (.0092)	-2.31
Visits per enrollee	.0991 (.0208)	.0712 (.0163)	-1.06	.0370 (.0122)	-2.57
Visits per user	1.543 (.157)	1.326 (.165)	-0.95	1.182 (.1734)	-1.54
Sample size of enrollees (persons)	545	801		351	
			Adults Aged 45-65		
Probability of any	.1569 (.0295)	.0817 (.0178)	-2.18	.0678 (.0228)	-2.39
Visits per enrollee	.2843 (.0603)	.109 (.026)	-2.67	.1356 (.071)	-1.60
Visits per user	1.813 (.187)	1.333 (.1402)	-2.04	200 (.810)	0.23
Sample size (persons)	204	257		118	

Table 7.21

AVERAGE FLU IMMUNIZATION USE FOR THREE-YEAR TOTAL, BY PLAN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Adults Aged 17-44		
Probability of any	.0220 (.0068)	.0162 (.0056)	-0.66	.00855 (.0049)	-1.611
Visits per enrollee	.385 (.0137)	.0250 (.0121)	-0.74	.01425 (.00939)	-1.46
Visits per user	1.750 (.248)	1.539 (.366)	-0.48	1.667 (.544)	-0.14
Sample size of enrollees (persons)	545	801		351	
			Adults Aged 45-65		
Probability of any	.1225 (.0075)	.0545 (.0141)	-2.20	.0424 (.0185)	-2.42
Visits per enrollee	.2402 (.0582)	.0778 (.0229)	-2.60	.1017 (.0687)	-1.54
Visits per user	1.960 (.222)	1.429 (.195)	-1.80	2.40 (1.25)	0.35
Sample size (persons)	204	257		118	

Table 7.22

AVERAGE PREVENTIVE-CARE USE FOR THREE-YEAR TOTAL, BY PLAN: MALES
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Males Aged 17-44		
Probability of any	.2724 (.0274)	.2308 (.0217)	-1.19	.1724 (.0282)	-2.54
Visits per enrollee	.4627 (.058)	.3316 (.0383)	-1.89	.2184 (.0393)	-3.49
Visits per user	1.6986 (.128)	1.437 (.0876)	-1.68	1.267 (.0935)	-2.71
Sample size of enrollees (persons)	268	377		174	
			Males Aged 45-65		
Probability of any	.3908 (.0523)	.2743 (.042)	-1.74	.1875 (.0563)	-2.64
Visits per enrollee	.9310 (.1664)	.4956 (.0962)	-2.27	.4792 (.202)	-1.73
Visits per user	2.382 (.282)	1.807 (.216)	-1.62	2.556 (.755)	0.21
Sample size (persons)	87	113		48	

Table 7.23

AVERAGE PREVENTIVE-CARE USE FOR THREE-YEAR TOTAL, BY PLAN: FEMALES
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Females Aged 17-44		
Probability of any	.8376 (.0220)	.7689 (.0208)	-2.27	.7119 (.0343)	-3.08
Visits per enrollee	2.014 (.092)	1.823 (.0754)	-1.61	1.559 (.109)	-3.19
Visits per user	2.405 (.0893)	2.371 (.0742)	-0.29	2.191 (.109)	-1.52
Sample size of enrollees (persons)	277	424		177	
			Females Aged 45-65		
Probability of any	.7692 (.0390)	.6528 (.0397)	-2.09	.6857 (.0555)	-1.23
Visits per enrollee	2.060 (.167)	1.6944 (.1563)	-1.60	1.500 (.1735)	-2.32
Visits per user	2.678 (.1698)	2.596 (.1801)	-0.33	2.188 (.1808)	-1.98
Sample size of enrollees (persons)	117	144		70	

Table 7.24

AVERAGE PAP SMEAR USE FOR THREE-YEAR TOTAL, BY PLAN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Females Aged 17-44		
Probability of any	.722 (.0271)	.6580 (.0234)	-1.79	.548 (.0377)	-3.75
Visits per enrollee	1.357 (.0707)	1.245 (.0586)	-1.22	1.00 (.0883)	-3.16
Visits per user	1.880 (.0674)	1.893 (.0577)	0.14	1.825 (.0982)	-0.46
Sample size of enrollees (persons)	277	424		177	
			Females Aged 45-65		
Probability of any	.6496 (.0441)	.5278 (.0416)	-2.01	.5000 (.0598)	-2.01
Visits per enrollee	1.350 (.125)	1.0556 (.1052)	-1.81	.9286 (.1345)	-2.30
Visits per user	2.079 (.1299)	2.000 (.122)	-0.44	1.8571 (.152)	-1.11
Sample size of enrollees (persons)	117	144		70	

Table 7.25

AVERAGE PAP OR GYN UTILIZATION FOR THREE-YEAR TOTAL, BY PLAN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Females Aged 17-44		
Probability of any	.7509 (.0257)	.7052 (.0226)	-1.33	.6102 (.037)	-3.12
Visits per enrollee	1.505 (.0750)	1.427 (.0629)	-0.88	1.141 (.090)	-3.11
Visits per user	2.005 (.0715)	2.023 (.0612)	0.20	1.870 (.0920)	-1.15
Sample size of enrollees (persons)	277	424		177	
			Female Aged 45-65		
Probability of any	.6581 (.0439)	.5625 (.0413)	-1.59	.5143 (.0597)	-1.94
Visits per enrollee	1.410 (.128)	1.1528 (.113)	-1.51	.9857 (.1407)	-2.23
Visits per user	2.143 (.132)	2.0494 (.1329)	0.50	1.9167 (.159)	-1.09
Sample size of enrollees (persons)	117	144		70	

Table 7.26

AVERAGE IMMUNIZATION USE FOR ANY YEAR, BY PLAN: ADULTS
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Adults Aged 17-44		
Probability of any	.0275 (.0053)	.0200 (.004)	-1.14	.0123 (.0041)	-2.28
Visits per enrollee	.0330 (.0069)	.0237 (.0054)	-1.06	.0213 (.0041)	-2.57
Visits per user	1.200 (.0697)	1.188 (.0822)	-0.12	1.00 (0.00)	-2.87
Sample size of enrollees (person/years)	1635	2403		1053	
			Adults Aged 45-65		
Probability of any	.085 (.018)	.0350 (.0082)	-2.51	.0254 (.0089)	-2.95
Visits per enrollee	.0948 (.020)	.0363 (.0087)	-2.67	.0452 (.0237)	-1.60
Visits per user	1.115 (.0425)	1.037 (.0354)	-1.42	1.778 (.0538)	1.23
Sample size of enrollees (person/years)	612	771		354	

Table 7.27

AVERAGE FLU IMMUNIZATION USE FOR ANY YEAR, BY PLAN: ADULTS
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Adults Aged 17-44		
Probability of any	.0098 (.0033)	.0071 (.0029)	-0.61	.0048 (.0031)	-1.10
Visits per enrollee	.0128 (.0046)	.0083 (.0040)	-0.74	.0048 (.0031)	-1.46
Visits per user	1.313 (.120)	1.176 (.121)	-0.90	1.00 (0.00)	-1.19
Sample size of enrollees (person/years)	1635	2403		1053	
			Adults Aged 45-65		
Probability of any	.0719 (.0178)	.0246 (.0071)	-2.48	.0169 (.0078)	-2.85
Visits per enrollee	.0801 (.0194)	.0259 (.0076)	-2.60	.0339 (.0229)	-1.54
Visits per user	1.114 (.0466)	1.053 (.0492)	-1.42	2.000 (.745)	-1.23
Sample size of enrollees (person/years)	612	771		354	

Table 7.28

AVERAGE PREVENTIVE-CARE USE FOR ANY YEAR, BY PLAN: MALES
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Males Aged 17-44		
Probability of any	.121 (.013)	.0928 (.0099)	-1.66	.0689 (.0121)	-2.86
Visits per enrollee	.154 (.019)	.111 (.013)	-1.89	.0728 (.0131)	-3.49
Visits per user	1.278 (.0656)	1.191 (.0456)	-1.10	1.056 (.0374)	-2.95
Sample size of enrollees (person/years)	804	1131		522	
			Males Aged 45-65		
Probability of any	.222 (.0341)	.1298 (.023)	-2.25	.0972 (.0325)	-2.65
Visits per enrollee	.3103 (.0555)	.1652 (.0321)	-2.27	.1597 (.0673)	-1.73
Visits per user	1.397 (.0885)	1.273 (.0888)	-0.99	1.643 (.373)	-0.64
Sample size of enrollees (person/years)	261	339		144	

Table 7.29

AVERAGE PREVENTIVE-CARE USE FOR ANY YEAR, BY PLAN: FEMALES
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Females Aged 17-44		
Probability of any	.526 (.020)	.482 (.017)	-1.66	.426 (.026)	-3.04
Visits per enrollee	.671 (.038)	.608 (.025)	-1.61	.520 (.036)	-3.19
Visits per user	1.277 (.0297)	1.261 (.0248)	-0.041	1.221 (.0342)	-1.23
Sample size of enrollees (person/years)	831	1272		531	
			Females Aged 45-65		
Probability of any	.490 (.033)	.414 (.030)	-1.68	.405 (.041)	-1.61
Visits per enrollee	.687 (.056)	.565 (.052)	-1.60	.500 (.058)	-2.32
Visits per user	1.401 (.0519)	1.363 (.0669)	-0.45	1.235 (.0585)	-2.12
Sample size of enrollees (person/years)	351	432		210	

Table 7.30

AVERAGE PAP SMEAR USE FOR ANY YEAR, BY PLAN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Females aged 17-44		
Probability of any	.409 (.020)	.376 (.017)	-1.28	.299 (.025)	-3.44
Visits per enrollee	.452 (.024)	.415 (.020)	-1.22	.333 (.029)	-3.16
Visits per user	1.106 (.018)	1.105 (.0156)	-0.05	1.113 (.0291)	0.021
Sample size of enrollees (person/years)	831	1272		531	
			Females aged 45-65		
Probability of any	.382 (.032)	.310 (.028)	-1.66	.290 (.041)	-1.75
Visits per enrollee	.450 (.042)	.352 (.035)	-1.81	.310 (.045)	-2.30
Visits per user	1.179 (.0378)	1.134 (.0346)	-0.87	1.066 (.030)	-2.35
Sample size of enrollees (person/years)	351	432		210	

Table 7.31

AVERAGE PAP OR GYN UTILIZATION FOR ANY YEAR, BY PLAN
(Standard errors in parentheses)

Outcome	Free	Pay	t-Statistic for Difference from Free Plan	Individual Deductible	t-Statistic for Difference from Free Plan
			Females Aged 17-44		
Probability of any	.439 (.020)	.417 (.017)	-0.86	.339 (.025)	-3.09
Visits per enrollee	.502 (.025)	.476 (.021)	-0.80	.380 (.030)	-3.11
Visits per user	1.143 (.0205)	1.142 (.0175)	-0.04	1.122 (.0275)	-0.59
Sample size of enrollees (person/years)	831	1272		531	
			Females Aged 45-65		
Probability of any	.393 (.032)	.333 (.029)	-1.37	.305 (.042)	-1.66
Visits per enrollee	.470 (.043)	.384 (.038)	-1.51	.329 (.047)	-2.23
Visits per user	1.196 (.0399)	1.153 (.0406)	-0.75	1.078 (.0317)	-2.31
Sample size of enrollees (person/years)	351	432		210	

Table 7.32

COST PER PROCEDURE USED IN CALCULATING
"COST TO BRING UP TO STANDARD"
(In 1984 dollars)

For Adults

Sex and Age Group	Office Visit	Upgrade	Pap	Mammogram
Males, 17-44	28.80	11.91	--	--
Males, 45-65	26.46	9.87	--	--
Females, 17-44	28.61	10.85	12.55	87.32
Females, 45-65	30.92	1.66	12.55	87.32

Children, 0-16
Office visit.....26.08
DPT.....6.65
Polio.....5.75

Table 7.33

PROBABILITIES OF USE IN THREE YEARS USED IN CALCULATING
"COST TO BRING UP TO STANDARD": ADULTS

Sex and Age Group	No Use in 3 Years	Had Only Nonpreventive in 3 Years	Had a Pap Smear in 3 Years	Had Preventive But No Pap in 3 Years
Males, 17-44	.144	.60	--	--
Males, 45-65	.117	.58	--	--
Females, 17-44	.064	.16	.66	.275
Females, 45-65	.042	.25	.57	.36

Table 7.34

DISTRIBUTION OF POLIO AND DPT SHOTS BY NUMBER OF VISITS IN FIRST 18 MONTHS[a]

Number of Visits	Number of DPT Shots	Number of Polio Vaccinations	Percent
0	0	0	7.22
1	0	0	4.12
1	1	1	1.03
2	1	0	1.03
3+	0	0	12.37
3+	1	0	2.06
3+	1	1	8.25
3+	1	2	1.03
3+	2	0	1.03
3+	2	1	3.09
3+	2	2	12.37
3+	2	3	2.06
3+	3	2	1.03
3+	3+	3+	43.30

[a]Used in calculation of cost to bring newborns up to standard for DPT and Polio.

VIII. STATISTICAL PROCEDURES

This section is concerned with a more technical statement of our statistical procedures, some of which are well known while others are original to this research. Original statistical models are elaborated in more detail.

We begin with a discussion of the procedure for calculating aggregate cost of medical services from costs per visit and visit counts for the various types of medical services. Next, we discuss our statistical procedures for costs and changes in health status, and for visit counts. The count models are elaborated in considerably more detail because they include original developments.

Throughout, our statistical models incorporate or correct for correlation among observations. Observations are correlated for several reasons. First, although observations for a given person may be independent from period to period, persistent individual differences in long-run mean levels will cause aggregate counts to be correlated over time. This is typically termed heterogeneity among individuals. Second, because persons in the same household are more likely to behave similarly than are unrelated people, the observations of households may be correlated as well. The sources of correlation are called components of variation; and if the components are independent of measured variables, then this is called a random effects model.

For each of these models we consider two basic sets of covariates: (1) a set of basic contrasts including year indicators, indicators for having taken the entry physical exam (interacted with year to allow the effect to vary as time passed), and in relevant cases other preventive care visits,[1] the set being termed ANOVA, and (2) a fuller set of covariates including demographic variables, cost-sharing plans, and so forth (as discussed in Sec. VI), termed ANOCOVA.

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[1]Average number over three years and annual deviation for each person.

ASSESSING AGGREGATE EFFECTS

We disaggregate total costs into three types of medical care: inpatient admissions (hospitalizations), outpatient visits involving preventive services, and outpatient visits involving nonpreventive ambulatory services.[2] For each type of care, we separately examine the number of visits or admissions and costs of visits. In each case, the number of encounters with the medical care system (visits) is discrete integer valued, and our modeling reflects this. Conditional on some care being received, we also model the intensity of these visits in terms of the cost per visit (for each of these three types of care). These six equations taken together constitute the components of total medical cost, where

Total medical cost = (number of hospital visits) x (cost per hospital visit)
+ (number of nonpreventive visits) x (cost per nonpreventive visit)
+ (number of preventive visits) x (cost per preventive visit).

Here we focus on the total effects over all types of medical services of an exogenously provided physical examination, randomly allocated to participants in the HIE, and of an additional other preventive visit. We emphasize in our discussion the effects of these on each of the component equations. In both the visit and count models that we report, the effects of regressors (covariates) on the distribution means are proportional. Therefore, in both the visit-count equations and the cost-per-visits equations, we assess (in effect) the percentage change in use of health care resources due to receiving the physical examination or an additional preventive visit last year (conditional on the total number of preventive visits over the three years). Our approach is to assess combinations (pairwise) for each type of medical care,[3] and then to draw upon knowledge about correlations across equations to make the inferences we need.

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[2]An alternative way to assess the effects of preventive care on use of medical services would be to use total medical costs as a dependent variable in an ANOCOVA or multiple regression model of some sort. Duan, Manning, Morris, and Newhouse (1982) also discuss these and other issues in modeling for medical expenditure data.

[3]If there were only one type of medical care, we could simply assess the sum of the coefficients of the examination variable in the

COST PER VISIT OR PER ADMISSION

Our cost-equation estimates are based on generalized least squares regression procedures. The dependent variable is the logarithmic transformation of cost per visit or per admission. We used a two-step, least-squares estimation procedure for a nested random-effects variance-components model for individual and family (household) effects (Searle, 1971). The first step estimates the intrafamily and intraperson correlations from ordinary least squares (OLS) residuals. In the second step, the model is reestimated by generalized least squares using the estimated correlations.

CHANGE IN HEALTH STATUS

Our change in health status (GHINDX) equation estimates are also based on generalized least squares regression procedures. We used a two-step, least-squares estimation procedure for a random effects variance components model for family (household) effects. The first step estimates the intrafamily correlation from OLS residuals. In the second step, the model is reestimated by generalized least squares using the estimated correlation.

NEGATIVE BINOMIAL COUNT MODELS

We use a negative binomial regression model to estimate the response of visits and admissions to the effect of the physical examination, cost sharing, and the other covariates. The negative binomial distribution is an appealing model for visits and admissions because it can yield two of the characteristics observed in medical use data: a large proportion of zero visits and a skewed distribution of positive use (counts). The negative binomial regression model is more appealing than a Poisson regression because the variances of both visits and admissions exceed their means; data from a Poisson distribution

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number-of-visits and cost-per-visit equations, accounting as appropriate for correlations between the error terms of the equations estimated for number of visits and cost per visit. Each coefficient would represent a proportional change in a component of total use. As it turns out, our empirical results allow us to make these inferences without actually deriving the standard errors of the summation.

should have equal mean and variance. In fact, the distributions have overdispersion relative to the negative binomial, which is evidence of heterogeneity among individuals and households incorporated into our models.[4]

This section lays out the basic negative binomial count model including versions with covariates, with repeated measurement (panel data), and with a mixing distribution. The count model is developed in a generic way to include a combination of panel data (three years in our study), intrahousehold correlations (all members of a household are included in the sample), and covariation across count types. These relationships are introduced through a discrete[5] multivariate mixing distribution.

THE BASIC NEGATIVE BINOMIAL MODEL

The negative binomial model can be generated from an underlying Poisson model. Let each individual's (i's) visits be drawn independently from a Poisson distribution with rate λ_i. If different individuals have different rates that are samples from a Gamma distribution with shape parameter A and scale parameter β, then the observed number of visits follows a negative binomial distribution, where $\theta = (1 + \beta)^{-1}$ so that

$$P(\text{visits} = y) = \frac{\Gamma(A + y)}{\Gamma(A)\ \Gamma(y + 1)}\ \theta^A(1 - \theta)^y. \qquad y = 0, 1, 2, 3, \ldots$$

The expected values for the sample mean and variance visits are

$$E(\text{visits}) = A(1 - \theta)/\theta = A/\beta$$

$$\text{Var}(\text{visits}) = A(1 - \theta)/\theta^2 = A(1 + \beta)/\beta^2.$$

---

[4]We also estimated versions of the simpler negative binomial model without heterogeneity. Results are not affected in any substantive way.

[5]A continuous mixture model based on a form of multivariate β was considered but not used. That alternative model is presented in App. A.

Different outcomes (preventive and nonpreventive visits and admissions) have different parameters (A and θ).

PRELIMINARIES: NEGATIVE BINOMIAL COUNTS AND MIXING MODELS

We developed models for counts-data based on the mixture of negative binomial distributions. We prefer such models to more conventional linear models because (1) our outcomes are counts, (2) we observe a large number of cases with zero counts (e.g., no hospitalization), and (3) the counts are highly skewed. Medical visit counts exhibit overdispersion relative to the Poisson and even the negative binomial distributions. In addition, simple cross-tabulation of panel counts indicates substantial correlation over time for given individuals. Therefore, our models are based on mixtures of negative binomial count processes.[6]

The basic negative binomial model, denoted $y \sim NB(A,\theta)$, has density function given by

$$\frac{\Gamma(A + y)}{\Gamma(A)\Gamma(y + 1)} \theta^{A}(1 - \theta)^{y} \qquad y = 0, 1, 2, 3, \ldots ; A > 0, 0 < \theta < 1 \tag{8.1}$$

The mean and variance are, respectively, $A(1 - \theta)/\theta$ and $A(1 - \theta)/\theta^2$. The model is sometimes further parameterized to depend on covariates so that either (1) $\ell nA = \beta'X$ or (2) $\ell n(1 - \theta)/\theta = \beta'X$. The two models differ primarily in the way the variance is affected by covariates. We adopt the former convention.

The distribution may be further generalized by assuming a "mixing" distribution for either A or θ.[7] The simple NB model results when the mixing distribution has zero variance. We consider models where θ

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[6]The Poisson may be interpreted as the number of occurrences of events in a fixed time interval, where each successive event is an identical but independent exponential distribution of waiting times to occurrence. The negative binomial model may be considered a Gamma mixture of Poisson models.

[7]If A is assumed to vary, it is generally assumed itself to follow a discrete integer-valued distribution. See Johnson and Kotz (1969).

varies. Whatever the assumed distribution of θ, the mean is given by $A \cdot E((1 - \theta)/\theta)$.

A natural mixing distribution for θ is $\theta \sim \text{Beta}(a,b)$. The resulting Compound Negative Binomial (CNB) distribution[8] has density

$$\frac{\Gamma(A + y)\Gamma(A + b)\Gamma(A + a)\Gamma(y + b)}{\Gamma(A)\Gamma(y + 1)\Gamma(a)\Gamma(b)\Gamma(y + A + a + b)} \qquad y = 0, 1, 2, \ldots \qquad (8.2)$$

The parameter θ in the NB model could just as easily be mixed by a discrete finite-valued distribution.[9] The parameter θ then takes G values, each with probability $P(\theta_j) j = 1,K$ such that the sum of probabilities is one. The resulting distribution has density

$$\frac{\Gamma(A + y)}{\Gamma(A)\Gamma(y + 1)} \sum_{g=1}^{G} \theta_g^A (1 - \theta_g)^y \, p(\theta_g) \qquad (8.3)$$

The NB mixture model extends readily to panel data by assuming that realizations are independently and identically distributed NB in repeated periods, conditional on θ. The product of independent NB densities with the same θ may be mixed by the Beta(a,b). The continuous form of the model (and other related models) is explored by Hausman, Hall, and Griliches (1984), who term it the variance component NB model (VC-NB).[10] An equivalent model is obtained by Mosimann (1963) by mixing a Negative Multinomial distribution by the Dirichlet (a form of multivariate Beta) distribution; he terms the model the Compound Negative Multinomial (CNM). The distribution has density

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[8]Names of mixed or compound distributions vary depending on the source of the reference. Johnson and Kotz (1969) term this a Generalized Hypergeometric. Some of the names used here are simply logical extension of those appearing in the literature.

[9]While we have not seen this model in the literature, Everett and Hand (1982) report finite mixtures of Poisson and Binomial models.

[10]Hausman, Hall, and Griliches (1984) parameterize $A_{it} = \exp(\beta' X_{it})$ to allow individual and time variation in A.

$$\frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} \frac{\Gamma(\sum_t A_t + a)\Gamma(\sum_t y_t + b)}{\Gamma(\sum_t A_t + \sum_t y_t + a + b)} \prod_{t=1}^{T} \frac{\Gamma(A_t + y_t)}{\Gamma(A_t)\Gamma(y_t + 1)} \qquad y = 0, 1, 2, \ldots \tag{8.4}$$

This count model for panel data is analogous to variance component models for continuous variables. Assuming that A has the form $\ell nA = \beta'X$, the mean (log) is a linear regression plus an individual specific error component. Outcomes (counts) are stochastically distributed around the mean. However, the variance is not homoscedastic as is usually assured in continuous normal models. It is desirable to be able to introduce additional subcomponents, e.g., a household component, and correlation among components of different equations, i.e., count types. This is one of the objectives of this paper. A continuous mixture version and a finite mixture version are both presented in this section. The finite mixture model is further parameterized to include the effects of covariates on the distribution of parameters.

THE GENERIC MIXTURE MODEL WITH INDIVIDUAL AND HOUSEHOLD COMPONENTS AND WITH CORRELATION ACROSS COUNT TYPES

Before presenting a specific discrete mixture model, we lay out the generic form of the model.

Three types of medical visits are to be considered: (1) hospitalizations, h_{it}, (2) nonpreventive ambulatory, n_{it}, and (3) preventive, p_{it}. Each count type has a different distribution of parameters, but the distributions may be correlated. Members of the same household are considered a cluster. Household members are exchangeable and receive parameter draws from identical but not independent distributions. Different households are unrelated. Equations are denoted by k,m = h,n,p.

For any single individual, we assume that visit-counts follow the negative binomial distributions. The counts h_{it}, n_{it}, and p_{it} may be thought of as arising from a Gamma mixture of Poisson variables resulting from random visit arrival times over a fixed time period.

$$h_{it} \sim NB(A_{hit}, \theta_{hi}) \qquad A_{hi} > 0,\ 0 < \theta_{hi}, < 1 \tag{8.5}$$

$$n_{it} \sim NB(A_{nit}, \theta_{ni}) \qquad A_{nit} > 0,\ 0 < \theta_{ni} < 1 \tag{8.6}$$

$$p_{it} \sim NB(A_{pit}, \theta_{pi}) \qquad A_{pit} > 0,\ 0 < \theta_{pi} < 1. \tag{8.7}$$

The parameters θ are variable across individuals but constant over time. The parameters A are assumed to be loglinear functions of predetermined covariates X_{it}, so that[11]

$$\begin{aligned} \ell nA_{hit} &= \alpha_h' X_{it} \\ \ell nA_{nit} &= \alpha_n' X_{it} \\ \text{and } \ell nA_{pit} &= \alpha_p' X_{it}. \end{aligned} \tag{8.8}$$

For any given individual or pair of individuals, even in the same household, the numbers of visits of a particular type are independent from period to period through the panel, so that the joint density for T periods is the product of the individual period densities. However, counts will appear correlated over time and across household members in the aggregate because of variation in the unknown parameters across individuals. To illustrate this, consider the following moments for count type k (= h,n,p). The mean for count type k for person i in period t is

$$A_{kit}\ E((1 - \theta_{ki})/\theta_{ki}). \tag{8.9}$$

The covariance between periods t and τ for individual i is

[11]Since the values of covariates of particular interest (e.g., insurance plan and an initial physical examination) are largely experimentally determined, one would expect the random-effects assumption of conditional independence should be satisfied. However, this is tested empirically and rejected. The vectors X in each equation may be made different by restricting the α's.

$$A_{kit}\, A_{ki\tau}\, \mathrm{Var}((1 - \theta_{kit})/\theta_{ki}). \tag{8.10}$$

Counts of a given type will be correlated among household members due to covariation in θ. The covariance between household member i in period t and member j in period τ (including $t = \tau$) is

$$A_{kit}\, A_{kj\tau}\, \mathrm{Cov}((1 - \theta_{ki})/\theta_{ki},\ (1 - \theta_{kj})/\theta_{kj}). \tag{8.11}$$

Counts for a pair of count types k and m will be correlated if their respective θ parameters covary, either for an individual or for a pair of household members. The covariance between count types k and m in periods t and τ for individual i is given by

$$A_{kit}\, A_{mi\tau}\, \mathrm{Cov}((1 - \theta_{ki})/\theta_{ki},\ (1 - \theta_{mi})/\theta_{mi}). \tag{8.12}$$

Similarly, the covariance between household member i in period t and household number j in period τ (including $t = \tau$) is given by

$$A_{kit}\, A_{mj\tau}\, \mathrm{Cov}((1 - \theta_{ki})/\theta_{ki},\ (1 - \theta_{mj})/\theta_{mj}). \tag{8.13}$$

A DISCRETE MULTIVARIATE MIXTURE MODEL

The Multivariate Discrete Mixture Distribution

We assume that the parameters θ_h, θ_n, and θ_p each take a finite number of values. The probabilities of the discrete parameter values that each takes are denoted $P(\bullet)$. That is,

$$\begin{aligned}
&\theta_{hi} \in \{\theta_{hg} | g = 1, K_h\} \text{ such that} \sum P(\theta_{hi} = \theta_{hg}) = 1;\\
&\theta_{ni} \in \{\theta_{ng} | g = 1, K_n\} \text{ such that} \sum P(\theta_{ni} = \theta_{ng}) = 1; \text{ and}\\
&\theta_{pi} \in \{\theta_{pg} | g = 1, K_p\} \text{ such that} \sum P(\theta_{pi} = \theta_{pg}) = 1.
\end{aligned} \tag{8.14}$$

Without loss of generality, we define the parameter values to be ordered from smallest to largest by subscripts and make the following one-to-one monotonic transformation for each value of θ_{ki} (k = h,n,p):

$$\ell n(1 - \theta_{kg})/\theta_{kg} = C_{kg} \text{ so that} \tag{8.15}$$

$$\theta_{kg} = (1 + \exp(C_{kg}))^{-1} \text{ and } (1 - \theta_{kg}) = (1 + \exp(-C_{kg}))^{-1}. \tag{8.16}$$ [12]

It will prove useful to make a monotonic transformation of the θ parameter probabilities. The form of the transformation we have chosen for the probability of each value of the parameter θ (θ_h, θ_n or θ_p) is as follows (often termed an ordered probit model):

$$P(\theta = \theta_g) = \Phi(\tau_g - \mu) - \Phi(\tau_{g-1} - \mu) \qquad g = 1,k\,, \tag{8.17}$$

where $\tau_o = -\infty$, $\tau_K = \infty$, and Φ is the normal cdf.[13] This represents a simple reparameterization from (K - 1) values of P(•) to (K - 1) values of τ and μ. The correspondence is 1 to 1 after we normalize either μ or one of the τ's to zero. Implicitly, the variance is normalized to unity. There is a set of τ's and μ for each count type which uniquely determine the probability of the g-th value of the parameters θ.

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[12]This is the familiar logistic transformation. In application we further paramaterize the models so that $C_{kg} = C_{K1} - \Sigma r_q$, which orders the θ values and facilitates computational convergence.

One could extend the parameterization to include regressors, e.g., $\ell n(1 - \theta_{kg})/\theta_{kg} = C_{kg} + \alpha'_k X_i$. However, inclusion of regressors in both ℓnA and ℓnθ results in a high degree of collinearity and instability among parameter estimates. Similarly, one could further parameterize the parameter A to take a finite number of values so that $\ell nA_{kgt} = \alpha_{okg} + \alpha_k X$.

[13]Any continuous cdf would suffice at this point, but the normal specification will facilitate a parsimonious specification of the correlation structure among counts. It is parsimonious in that a minimum number of parameters is involved.

The correlation between a pair of θ parameters, say θ_h and θ_p, for a given individual is parameterized to depend on a single parameter ρ_{hp} as follows:

$$
\begin{aligned}
&P(\theta_h = \theta_{hg} \text{ and } \theta_p = \theta_{pq} | \rho_{hp}) = \\
&\quad \Phi_2((\tau_{hg} - \mu_h), (\tau_{pq} - \mu_p) | \rho_{hp}) - \Phi_2((\tau_{hg-1} - \mu_h), (\tau_{pq} - \mu_p) | \rho_{hp}) \qquad (8.18) \\
&\quad \Phi_2((\tau_{hg} - \mu_h), (\tau_{pq-1} - \mu) | \rho_{hp}) + \Phi_2((\tau_{hg-1} - \mu_h), (\tau_{pq-1} - \mu_p) | \rho_{hp})
\end{aligned}
$$

where Φ_2 denotes a bivariate normal cdf. Therefore, the discrete joint distributions are restricted to those that can be characterized by a single parameter, given the form-free (nonparametric) marginal distributions. There are thus three correlation parameters to characterize the joint distribution.[14] It should be noted, however, that ρ is not the correlation among θ values. It only determines the joint probabilities which, along with the θ values, determine the correlation among θ values. Analogous statements apply to pairs--the (n,p) and (h,n).

We similarly characterize the joint distribution of parameters across pairs of household members. There are similarly three cross-equation correlation parameters, say λ_{hp}. However, there are also three correlation parameters to characterize the relationship between household member parameters within each count type, say λ_{pp}. Again λ is not the parameter correlation, but parameter correlations depend on the parameters and joint probabilities resulting from λ.

To clarify this issue, consider the normal variates underlying the cumulative distribution functions above. Denote the three (count type) normal variates for a given individual by

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[14]A fully free joint discrete distribution for the triplet of count types h, n, and p would involve $(K_h - 1)(K_p - 1)(K_n - 1)$ additional parameters both for individuals and for pairs of household members.

$$\begin{pmatrix} y_h \\ y_n \\ y_p \end{pmatrix} = \begin{pmatrix} u_h \\ u_n \\ u_p \end{pmatrix} + \begin{pmatrix} f_h \\ f_n \\ f_p \end{pmatrix} + \begin{pmatrix} v_h \\ v_n \\ v_p \end{pmatrix} \tag{8.19}$$

where $Y = \{y_h, y_n, y_p\}'$ is the vector of normal variates, $U = \{u_h, u_n, u_p\}'$ is the vector of means, $F = \{f_h, f_n, f_p\}'$ is a vector of household components and $V = \{v_h, v_n, v_p\}'$ is a vector of individual specific components. By our earlier normalization to unit residual variance, the sum of the variances of f and v for a given equation is unity. The component F is present for all members of a household and thus induces correlation in counts between household members. V is uncorrelated across household members, but may be correlated across equations for the same individual. Therefore, there are three correlations between the three count types for a given individual and six correlations within and between count types for different household members.

The Resulting Count Distributions

The resulting aggregate distributions are each a finite mixture, and each is the distribution appropriate for a randomly chosen individual. The corresponding joint distributions for a panel of T periods is given by (subscripts i are dropped for notational simplicity):

$$f(h_1, \ldots, h_T) = \prod_{t=1}^{T} \frac{\Gamma(h_t + A_{ht})}{\Gamma(A_{ht})\Gamma(h_t + 1)} \sum_{g=1}^{K_h} \theta_{hg}^{\Sigma A_{ht}} (1 - \theta_{hg})^{\Sigma h_t} P(\theta_h = \theta_{hg});$$

$$f(n_1, \ldots, n_T) = \prod_{t=1}^{T} \frac{\Gamma(n_t + A_{nt})}{\Gamma(A_{nt})\Gamma(n_t + 1)} \sum_{g=1}^{K_n} \theta_{ng}^{\Sigma A_{nt}} (1 - \theta_{ng})^{\Sigma n_t} P(\theta_n = \theta_{ng});$$

$$f(p_1, \ldots, p_T) = \prod_{t=1}^{T} \frac{\Gamma(s_t + A_{st})}{\Gamma(A_{st})\Gamma(s_t + 1)} \sum_{g=1}^{K_s} \theta_{pg}^{\Sigma A_{pt}} (1 - \theta_{pg})^{\Sigma p_t} P(\theta_p = \theta_{pg});$$

The corresponding joint distributions are similar. For example, for counts h and n, the joint distribution of the six count observations (2 types, 3 periods each) is given by

$$f(h_i, \ldots, h_T, m_1, \ldots, m_T) = \prod_{t=1}^{T} \frac{\Gamma(h_t + A_{ht})\Gamma(m_t + A_{mt})}{\Gamma(A_{ht})\Gamma(A_{mt})\Gamma(h_t + 1)\Gamma(m_t + 1)} \tag{8.20}$$

$$\times \sum_{g=1}^{K_h} \sum_{q=1}^{K_m} \theta_g^{\Sigma h_t}(1 - \theta_g)^{\Sigma A_{ht}} \delta_q^{\Sigma m_t}(1 - \delta_q)^{\Sigma A_{mt}} p(\theta = \theta_g, \delta = \delta_q | \rho_\theta)_{\delta\epsilon}$$

To separate the family component from the individual component, similar distributions result for a randomly selected pair of individuals from the same household. Six additional correlations result from joint distributions analogous to those above replacing ρ by the parameter λ. The individual specific component is eliminated since counts for different household members are used, say hospitalization counts for person i and nonpreventive care for person j (i_j). In addition, a family component may introduce correlation in the same count type for different individuals from the same household. Therefore, there are three additional correlations λ for a total of 10(= 4(5)/2) λ's and 6 P's.

A Discrete Mixing Distribution with Covariates

We may generalize the above model for the mixing distribution to include covariates Z which affect the probability distribution of the parameters θ. That is, the probability of a high or low value of θ may differ for individuals with different values of regressors.[15] The set of covariates Z may be the same or different from the set of covariates X which affect the parameter A.

[15]A related model appears in Ochi and Prentice (1984). They introduce equicorrelated-probit Bernoulli probabilities to generate a binomial count distribution.

The covariates are allowed to shift the mean[16] of the underlying normal variate Y. That is,

$$\begin{pmatrix} u_h \\ u_n \\ u_p \end{pmatrix} = \begin{pmatrix} \beta_h \\ \beta_n \\ \beta_p \end{pmatrix} Z \tag{8.21}$$

Thus, for example, Eq. (8.17) becomes

$$P(\eta = \eta_g) = \Phi(\tau_g - \beta'_\eta Z) - \Phi(\tau_{g-1} - \beta'_\eta Z).$$

This parameterization allows us to relax, and test, the previous assumption that the mixing distribution is independent of the parameter $A = \exp(\alpha' X)$ of the conditional negative binomial $NB(A,\theta)$.

Estimation

Parameter values reported in Sec. IX are maximum likelihood estimates. The maximum likelihood estimates are obtained using the Berndt et al. (1974) iterative search procedure. The coefficient parameters α and β, and the mixing distribution support-points and probabilities, are estimated using the panel data for each count type for all individuals pooled. The intrahousehold correlation parameter is estimated for each count type using panel data on randomly selected pairs of household members.[17] Standard errors for the regression coefficients from the full sample are then corrected for this intrahousehold correlation using an adaptation of Huber's formula

[16]While we do not use it here, the relationships among the standardized normal variates Y could be one of simultaneous equations. Since the full covariance of stochastic elements is identified, the usual rank-order conditions for identification would suffice, i.e., zero restrictions on α and β.

[17]Conceptually more efficient estimates could be obtained by jointly including all household members. However, as a practical matter the multivariate probit that would be required for the mixing distribution is too expensive (and probably too inaccurate) for ML estimation.

suggested in Rogers (1983). The cross-count type correlation parameters are estimated using pairs of count types for individuals and for household pairs.

IX. ESTIMATES OF MODELS FOR VISIT COUNTS

This section presents the complete set of parameter estimates for the visit-count model. For each count type, parameters are presented in the following order: α coefficients for the negative binomial parameter A in $\ell nA - \alpha X$; and finite mixing distribution support points Θ and their probabilities.[1] Finally, the correlation parameters determining the pattern of covariation across members of the same household and between count types are presented.

These estimates form the basis for the visit-rate response in Tables 4.1 and 4.2. In those tables, we reported the average of the exponentiated physical exam coefficients over the three years. Because the model is a proportional one (log specification), the exponential of the coefficient provides an estimate of the percentage response of visits or admissions to a unit charge in the independent variables.

PREVENTIVE VISITS

Estimates of the regression coefficients α in the equation $\ell nA = \alpha' X$ and $u = \beta_o$ are presented in Table 9.1. Estimates of the number of support points, their values, and probabilities are presented in Table 9.2. Two support points are significant.

ALL NONPREVENTIVE OUTPATIENT VISITS

Estimates of the regression coefficients α in the equations $\ell nA = \alpha' X$ and $u = \beta_o$ are presented in Table 9.3. Estimates of the number of support points, their values, and probabilities are presented in Table 9.4. Five support points are significant.

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[1]In each case the marginal contribution of an additional value was very highly significant until one beyond those reported, when the marginal contribution was clearly small. Additional estimates which incorporate the β coefficients in the determination of the probability density of support points are presented in App. A.

Table 9.1

PREVENTIVE VISIT COUNTS
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)
CONSTANT, α_o	Constant	4.47 (-106.396)	3.843 (81.84)
YEAR 2	Year 2 of study	-.286 (-4.450)	-.257 (-3.909)
YEAR 3	Year 3 of study	-.325 (-5.297)	-.286 (-4.524)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	-.135 (-2.513)	-.053 (-.929)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	.008 (.135)	.064 (1.024)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	.078 (1.247)	.138 (2.209)
SEATTLE	Seattle, Wash.		-.350 (-2.461)
FITCHBURG	Dummy indicating Fitchburg, Mass.		-.131 (-.947)
FRANKLIN	Dummy indicating Franklin, Mass.		-.022 (-.162)
WKLYHR	Weekly HLTH report type		.031 (.548)
NOHR	HLTH report type is zero		.010 (.165)
TERM3	Offered 3-year enrollment		.027 (.756)
AGE	Age at enrollment		.012 (3.246)
LNAGE	Log of age		-.346 (-9.056)

Table 9.1--continued

Variables, X	Definitions	(1)	(2)
CHILD	Child		1.108 (11.749)
FAD1	Indicates female aged 18-39		1.608 (24.788)
FAD2	Indicates female aged ≥ 30		1.57 (17.925)
ADULT2	Age ≥ 40		.369 (3.357)
LNINC	Log of 75-76 income, min = 1000		.170 (5.369)
LFAM	Log of family size		-.215 (-4.798)
TWOHEAD	Two heads in HHLD		.038 (.660)
AFDC	AFDC family		.112 (1.510)
MISINC	75-76 income missing		-.140 (-1.385)
MISAFDC	AFDC missing		-.196 (-1.415)
BLACK	Black indicator		-.130 (-1.549)
GHINDX	General Health Index: actual: non-Dayton		-.012 (-1.767)
GHINMIS	Indicates GHINDX is missing		-2.201 (-1.622)
FORM1	Infant health form		.004 (.038)
FORM2	Pediatric health form		-.089 (-1.171)
GHI_GHMS	GHINMIS * GHINDX		.063 (1.627)

Table 9.1--continued

Variables, X	Definitions	(1)	(2)
P25	Indicates coinsurance rate 25%		-.100 (-2.247)
P50	Indicates coinsurance rate 50%		-.170 (-2.664)
P95	Indicates coinsurance rate 95%		-.342 (-7.380)
IDP	Individual deductible plan		-.338 (-7.071)
GHI2	GHINDX square		.0001 (1.867)
GH2_GHMS	GHINMIS * GHI2		-.0005 (-1.666)
CONSTANT, β_o	Constant	.064 (1.644)	.894 (13.948)

Table 9.2

DISCRETE MIXING DISTRIBUTION
FOR PREVENTIVE VISITS

	Support-Point Points	
Parameter	1	2
θ_p	.990	.999
$P(\theta_p)$	.654	.346
$(1-\theta_p)/\theta_p$	.010	.001

Table 9.3

ALL NONPREVENTIVE OUTPATIENT VISIT-COUNTS: PARAMETER ESTIMATES
(t-Statisticis in parentheses)

Variables, X	Definitions	(1)	(2)	(3)
CONSTANT, α_o	Constant	.795 (19.611)	.645 (16.142)	.663 (18.108)
YEAR 2	Year 2 of study	-.041 (-1.116)	-.048 (-1.301)	-.054 (-1.462)
YEAR 3	Year 3 of study	-.139 (-4.119)	-.142 (-4.279)	-.148 (-4.489)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	-.053 (-1.303)	.050 (1.244)	.029 (.703)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	-.118 (-2.865)	-.003 (-.068)	-.034 (-.838)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	.023 (.564)	.129 (3.115)	.099 (2.391)
P1-PBAR	(Prev. visits Year 1 minus PBAR) * YEAR2	.102 (1.008)	.065 (.655)	
P2-PBAR	(Prev. visits Year 2 minus PBAR) * YEAR 3	-.049 (-.559)	-.027 (-.295)	
PBAR	Annual average number of preventive visits	.566 (8.895)	.427 (7.335)	
SEATTLE	Seattle, Wash.		.019 (.120)	-.016 (-.091)
FITCHBURG	Dummy indicating Fitchburg, Mass.		-.183 (-1.138)	-.193 (-1.129)
FRANKLIN	Dummy indicating Franklin, Mass.		-.286 (-1.793)	-.284 (-1.660)
WKLYHR	Weekly HLTH report type		.009 (.180)	-.004 (-.089)
NOHR	HLTH report type is zero		.048 (.861)	.060 (1.052)

Table 9.3--continued

Variables, X	Definitions	(1)	(2)	(3)
TERM3	Offered 3-year enrollment		.015 (.466)	.034 (.431)
AGE	Age at enrollment		.010 (2.861)	.010 (3.100)
LNAGE	Log of age		-.078 (-1.628)	-.139 (-3.161)
CHILD	Child		.336 (4.415)	.320 (4.157)
FAD1	Indicates female aged 18-39		.458 (9.535)	.510 (10.832)
FAD2	Indicates female aged ≥ 30		.225 (17.925) (4.265)	.275 (4.766)
ADULT2	Age ≥ 40		.102 (1.206)	.114 (1.332)
LNINC	Log of 75-76 income, min = 1000		.119 (4.380)	.119 (4.545)
LFAM	Log of family size		-.160 (-3.874)	-.171 (-4.114)
TWOHEAD	Two heads in HHLD		.115 (2.215)	.084 (1.589)
AFDC	AFDC family		.080 (1.230)	.100 (1.528)
MISINC	75-76 income missing		-.061 (-.599)	-.037 (-.384)
MISAFDC	AFDC missing		-.166 (-1.345)	-.199 (-1.664)
BLACK	Black indicator		-.546 (-7.424)	-.417 (-5.721)
GHINDX	General Health Index: actual: non-Dayton		-.012 (-11.188)	-.011 (-10.142)
GHINMIS	Indicates GHINDX is missing		.879 (3.117)	.327 (1.153)

Table 9.3--continued

Variables, X	Definitions	(1)	(2)	(3)
FORM1	Infant health form		.191 (1.770)	.118 (1.106)
FORM2	Pediatric health form		-.044 (-.660)	-.086 (-1.278)
GHI_GHMS	GHINMIS * GHINDX		-.011 (-3.407)	-.004 (-1.173)
P25	Indicates coinsurance rate 25%		-.190 (-4.659)	-.202 (-5.077)
P50	Indicates coinsurance rate 50%		-.402 (-6.639)	-.395 (-6.612)
P95	Indicates coinsurance rate 95%		-.467 (-11.111)	-.474 (-11.276)
IDP	Indicates Individual Deductible plan		-.357 (-8.419)	-.372 (-8.749)
CONSTANT, β_o	Constant	.624 (10.082)	1.355 (10.105)	1.313 (39.139)

Table 9.4

DISCRETE MIXING DISTRIBUTION FOR ALL NONPREVENTIVE OUTPATIENT VISITS

	Support-Point Points				
Parameter	1	2	3	4	5
θ_n	.097	.196	.388	.647	.926
$P(\theta_n)$	.020	.076	.430	.361	.113
$(1-\theta_n)/\theta_h$	9.309	4.102	1.577	.546	.080

NONPREVENTIVE OUTPATIENT VISITS INVOLVING PREVENTIVE RELATED OUTCOMES ("TARGETED")

Estimates of the regression coefficients α in the equation $\ell nA = \alpha'X$ and $u = \beta_o$ are presented in Table 9.5. Estimates of the number of support points, their values, and probabilities are presented in Table 9.6. Two support points are significant.

Estimates of the number of support points, their values, and probabilities are presented in Table 9.6. Three support points are significant.

INPATIENT VISITS

Estimates of the regression coefficients α in the equation $\ell nA = \alpha'X$ and $u = \beta_o$ are presented in Table 9.7. Estimates of the number of support points, their values, and probabilities are presented in Table 9.8. Two support points are significant.

CORRELATIONS AMONG HOUSEHOLD MEMBERS AND BETWEEN COUNT TYPES

Visit counts are much more correlated among household members than in the general population, especially for nonpreventive care. Correlation among count types is much greater for an individual than for members of a household, as expected. However, substantial correlations persist even across count types for members of the same household, especially for nonpreventive ambulatory care.

Estimates of intrahousehold and correlations across count types are presented in Table 9.9.

IMPLICATIONS OF THE MIXING DISTRIBUTIONS

The importance of variation in θ parameters is illustrated in Table 9.10, which reports the count distributions conditional on the various θ values.

Table 9.5

OUTPATIENT VISIT COUNTS FOR "TARGETED" NONPREVENTIVE MEDICAL CARE: PARAMETER ESTIMATES
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)	(3)
CONSTANT, α_o	Constant	.079 (1.006)	-.993 (-13.415)	-.967 (-12.973)
YEAR 2	Year 2 of study	-.057 (-.734)	-.046 (-.603)	-.055 (-.732)
YEAR 3	Year 3 of study	-.042 (-.585)	-.030 (-.460)	-.036 (-.554)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	-.036 (-.433)	.129 (1.703)	.107 (1.418)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	-.237 (-2.800)	-.052 (-.698)	-.072 (-.957)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	-.123 (-1.466)	.044 (.573)	.028 (.366)
P1-PBAR	(Prev. visits Year 1 minus PBAR) * YEAR2	-.365 (-1.087)	.300 (.791)	
P2-PBAR	(Prev. visits Year 2 minus PBAR) * YEAR3	-.411 (-1.132)	.200 (.534)	
PBAR	Annual average number of preventive visits	.618 (6.044)	.334 (4.006)	
SEATTLE	Seattle, Wash.		-.101 (-.285)	-.156 (-.428)
FITCHBURG	Dummy indicating Fitchburg, Mass.		-.702 (-1.968)	-.697 (-1.900)
FRANKLIN	Dummy indicating Franklin, Mass.		-.881 (-2.484)	-.898 (-2.468)
WKLYHR	Weekly HLTH report type		.162 (2.019)	.179 (2.206)
NOHR	HLTH report type is zero		.162 (1.562)	.140 (1.328)

Table 9.5--continued

Variables, X	Definitions	(1)	(2)	(3)
TERM3	Offered 3-year enrollment		.059 (1.111)	.062 (1.162)
AGE	Age at enrollment		.045 (7.277)	.046 (7.433)
LNAGE	Log of age		-.191 (-1.432)	-.257 (-1.906)
CHILD	Child		.206 (1.381)	.200 (1.345)
FAD1	Indicates female aged 18-39		.740 (8.694)	.762 (8.902)
FAD2	Indicates female aged ≥ 40		.296 (4.050)	.293 (4.048)
ADULT2	Age ≥ 40		.210 (1.571)	.246 (1.826)
LNINC	Log of 75-76 income, min = 1000		.193 (3.913)	.192 (3.796)
LFAM	Log of family size		-.183 (-2.738)	-.176 (-2.596)
TWOHEAD	Two heads in HHLD		.092 (1.031)	.069 (.763)
AFDC	AFDC family		.076 (.544)	.091 (.652)
MISINC	75-76 income missing		.091 (.497)	.068 (.371)
MISAFDC	AFDC missing		-.227 (-1.027)	-.231 (-1.045)
BLACK	Black indicator		-.221 (-1.970)	-.231 (-2.100)
GHINDX	General Health Index: actual: non-Dayton		-.021 (-10.636)	-.021 (-10.315)
GHINMIS	Indicates GHINDX is missing		.096 (.201)	-.080 (-.167)

Table 9.5--continued

Variables, X	Definitions	(1)	(2)	(3)
FORM1	Infant health form		-.398 (-1.440)	-.466 (-1.667)
FORM2	Pediatric health form		-.388 (-2.522)	-.424 (-2.774)
GHI_GHMS	GHINMIS * GHINDX		-.003 (-.514)	-.0003 (-.059)
P25	Indicates coinsurance rate 25%		-.154 (-2.284)	-.150 (-2.186)
P50	Indicates coinsurance rate 50%		-.348 (-3.444)	-.343 (-3.445)
P95	Indicates coinsurance rate 95%		-.385 (-5.396)	-.386 (-5.410)
IDP	Indicates individual deductible plan		-.285 (-3.801)	-.289 (-3.818)
CONSTANT, β_o	Constant	-.626 (-15.471)	-.127 (-2.125)	-.152 (-2.670)

Table 9.6

DISCRETE MIXING DISTRIBUTION
"TARGETED" NONPREVENTIVE CARE

	Support-Point Points		
Parameter	1	2	3
θ_h	.454	.848	.980
$P(\theta_h)$	.005	.265	.730
$(1-\theta_h)/\theta_h$	1.203	.179	.021

Table 9.7

ALL INPATIENT VISITS: PARAMETER ESTIMATES
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)
CONSTANT, α_o	Constant	-.030 (-.148)	-.282 (-1.346)
YEAR 2	Year 2 of study	-.105 (-.675)	-.095 (-.601)
YEAR 3	Year 3 of study	.043 (.290)	.042 (.280)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	.133 (.921)	.136 (.931)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	.165 (1.121)	.154 (1.047)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	.089 (.634)	.098 (.695)
P1-PBAR	(Prev. visits Year 1 minus PBAR) * YEAR2	.526 (1.618)	
P2-PBAR	(Prev. visits Year 2 minus PBAR) * YEAR3	-1.484 (-1.505)	
PBAR	Annual average number of preventive visits	.586 (3.884)	
SEATTLE	Seattle, Wash.	-.108 (-.309)	.006 (.016)
FITCHBURG	Dummy indicating Fitchburg, Mass.	.126 (.350)	.210 (.567)
FRANKLIN	Dummy indicating Franklin, Mass.	-.186 (-.530)	-.072 (-.200)
WKLYHR	Weekly HLTH report type	-.352 (-2.117)	-.359 (-2.166)
NOHR	HLTH report type is zero	-.123 (-.719)	-.108 (-.629)

Table 9.7--continued

Variables, X	Definitions	(1)	(2)
TERM3	Offered 3-year enrollment	-.074 (-.771)	-.090 (-.944)
AGE	Age at enrollment	.031 (3.081)	.029 (2.891)
LNAGE	Log of age	-.358 (-2.888)	-.303 (-2.485)
CHILD	Child	-.292 (-1.166)	-.276 (-1.106)
FAD1	Indicates female aged 18-39	.104 (.744)	.162 (1.169)
FAD2	Indicates female aged ≥ 40	-.051 (-.320)	-.013 (-.079)
ADULT2	Age ≥ 40	.005 (.019)	.034 (.142)
LNINC	Log of 75-76 income, min = 1000	-.004 (-.047)	-.009 (-.112)
LFAM	Log of family size	-.053 (-.434)	-.065 (-.535)
TWOHEAD	Two heads in HHLD	.107 (.687)	.102 (.655)
AFDC	AFDC family	.303 (1.583)	.323 (1.701)
MISINC	75-76 income missing	.448 (1.766)	.352 (1.450)
MISAFDC	AFDC missing	-.634 (-1.955)	-.566 (-1.784)
BLACK	Black indicator	-.438 (-1.751)	-.470 (-1.861)
GHINDX	General Health Index: actual: non-Dayton	-.020 (-6.496)	-.020 (-6.426)
GHINMIS	Indicates GHINDX is missing	1.567 (1.860)	1.781 (2.130)

Table 9.7--continued

Variables, X	Definitions	(1)	(2)
FORM1	Infant health form	-.046 (.140)	.147 (.444)
FORM2	Pediatric health form	-.050 (-.223)	-.038 (-.170)
GHI_GHMS	GHINMIS * GHINDX	-.020 (-2.010)	-.021 (-2.150)
ADLTPAY	Age ≥ 18 and coinsurance > 0	-.268 (-2.280)	-.275 (-2.348)
ADLTIDP	Age ≥ 18 and on individual deductible plan	-.379 (-2.483)	-.383 (-2.519)
CONSTANT, β_o	Constant	-.731 (-3.410)	-.411 (-1.950)

Table 9.8

DISCRETE MIXING DISTRIBUTION
FOR INPATIENT ADMISSIONS

	Support-Point Points		
Parameter	1	2	3
θ_h	.454	.848	.980
$P(\theta_h)$	.005	.265	.730
$(1-\theta_h)/\theta_h$	1.203	.179	.021

Table 9.9

CORRELATIONS AMONG VISIT-COUNT
TYPE MIXING PARAMETERS

	Same Individual		
	h	n	p
h	1.000		
n	.570 (.077)	1.000	
p	.371 (.120)	.441 (.043)	1.000
	Household Pair		
h	.643 (.250)		
n	-.047 (.121)	.486 (.044)	
p	-.264 (.251)	.295 (.082)	.590 (.154)

NOTE: h = inpatient, n = all nonpreventive, and p = preventive.

Table 9.10

COUNT DISTRIBUTIONS CONDITIONAL ON θ FOR T = 2
(Average over $\underset{\sim}{A}(X)$ and $\mu(Z)$)

Number of Visits	Hospitalizations θh			Nonpreventive θn				
θ	.980	.848	.454	.926	.647	.388	.196	.097
P(θ)	.730	.265	.005	.113	.361	.430	.076	.020
0	.983	.892	.617	.695	.381	.192	.107	.065
1	.016	.094	.215	.205	.212	.126	.068	.037
2	.000	.012	.092	.067	.136	.102	.059	.032
3		.002	.041	.022	.089	.085	.053	.029
4		.000	.019	.007	.060	.071	.049	.027
5			.009	.002	.041	.060	.045	.026
6			.004	.001	.027	.051	.041	.025
7			.002	.000	.018	.043	.038	.024
8			.001		.012	.037	.035	.023
9			.000		.008	.032	.033	.022
≥10					.015	.202	.472	.689

X. ESTIMATES OF MODELS FOR COST PER VISIT (LOG)

This section presents a complete set of estimates for the cost equations. For each type of medical services several alternative specifications are considered. Each includes both the relatively simple ANOVA specification (1) and an ANOCOVA specification (2) including demographic variables, cost-sharing covariates, baseline health status, and the preventive variables.

These equations include the entry physical examination indicator variable in such a way that its effect may differ each year after its occurrence (interactions with year-indicator variables). Estimates reported in Part 1 are based on the mean of the three-year values.

Table 10.1 presents the cost estimates for preventive care. Table 10.2 presents estimates for the cost per visit for all nonpreventive outpatient services. Table 10.3 presents estimates for the visit costs of "targeted" nonpreventive outpatient services, i.e., outpatient services related to those specific diseases that may be influenced by preventive care (eliminating the cost of irrelevant activities). Table 10.4 presents estimates for inpatient medical services.

Because the dependent variable is log of cost, the exponential of a coefficient is the estimate of the percentage change in cost from a unit change in the independent variable.

These tables provide the basis for the cost-per-unit values in Tables 4.1 and 4.2.

Table 10.1

LOG COST PER VISIT FOR PREVENTIVE MEDICAL CARE:
PARAMETER ESTIMATES
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)
CONSTANT	Constant	2.06 (76.9)	1.174 (4.15)
YEAR 2	Year 2 of study	.027 (0.61)	.036 (0.82)
YEAR 3	Year 3 of study	-.032 (-0.84)	-.032 (-0.82)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	-.063 (-1.83)	-.054 (-1.52)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	-.063 (-1.19)	-.063 (-1.17)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	-.017 (-0.37)	.004 (0.82)
SEATTLE	Dummy indicating Seattle, Wash.		.276 (2.73)
FITCHBURG	Dummy indicating Fitchburg, Mass.		.235 (2.34)
FRANKLIN	Dummy indicating Franklin, Mass.		.186 (1.85)
WKLYHR	Weekly HLTH report type		.074 (1.41)
NOHR	HLTH report type is zero		-.107 (-2.20)

Table 10.1--continued

Variables, X	Definitions	(1)	(2)
TERM3	Offered 3-year enrollment		
AGE	Age at enrollment		-.004 (-1.33)
LNAGE	Log of age		.031 (1.39)
CHILD	Child		-.402 (-4.48)
FAD1	Indicates female aged 18-39		-.066 (-1.14)
FAD2	Indicates female aged ≥ 40		-.052 (-0.74)
LNINC	Log of 75-76 income, Min = 1000		.078 (2.91)
LFAM	Log of family size		.012 (0.34)
TWOHEAD	Two heads in HHLD		.030 (0.68)
AFDC	AFDC family		.055 (1.05)
MISINC	Income missing		-.094 (-1.57)
MISAFDC	AFDC missing		.084 (1.09)
BLACK	Black indicator		-.020 (-0.32)

Table 10.1--continued

Variables, X	Definitions	(1)	(2)
GHINDX	General Health Index: actual: non-Dayton		.002 (2.35)
GHINMIS	Indicates GHINDX is missing		-.678 (-2.53)
FORM1	Infant health form		.066 (0.88)
FORM2	Pediatric health form		-.072 (-1.24)
GHI_GHMS	GHINMIS * GHINDX		.010 (3.28)
P25	Indicates coinsurance rate 25%		.028 (0.78)
P50	Indicates coinsurance rate 50%		-.005 (-0.08)
P95	Indicates coinsurance rate 95%		-.044 (-1.07)
IDP	Indicates Individual Deductible plan		.040 (1.12)

Table 10.2

LOG COST PER VISIT FOR ALL NONPREVENTIVE OUTPATIENT MEDICAL CARE:
PARAMETER ESTIMATES
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)	(3)
CONSTANT	Constant	2.392 (67.03)	2.453 (7.94)	2.99 (4.94)
YEAR 2	Year 2 of study	-.049 (-1.20)	-.055 (-1.45)	-.009 (-0.011)
YEAR 3	Year 3 of study	.040 (1.02)	.038 (1.12)	.038 (0.65)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	-.020 (-0.51)	-.008 (-0.21)	-.055 (-0.82)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	.019 (0.37)	.031 (0.66)	.065 (0.71)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	-.055 (-1.16)	-.047 (-1.11)	.018 (0.22)
P1-PBAR	(Prev. visits Year 1 minus PBAR) * YEAR2	.062 (1.67)	.084 (2.43)	
P2-PBAR	(Prev. visits Year 2 minus PBAR) * YEAR3	.090 (2.05)	.066 (1.73)	
PBAR	Annual average number of preventive visits	-.109 (-3.86)	-.069 (-2.69)	
SEATTLE	Dummy indicating Seattle, Wash.		.207 (1.84)	-.220 (-0.87)
FITCHBURG	Dummy indicating Fitchburg, Mass.		.189 (1.66)	-.199 (-0.78)
FRANKLIN	Dummy indicating Franklin, Mass.		.120 (1.12)	(-.125) (-0.50)
WKLYHR	Weekly HLTH report type		-.020 (-0.37)	-.004 (-0.06)
NOHR	HLTH report type is zero		-.034 (-0.57)	-.127 (-1.54)

Table 10.2--continued

Variables, X	Definitions	(1)	(2)	(3)
TERM3	Offered 3-year enrollment			
AGE	Age at enrollment		.0005	.001
			(0.23)	(0.26)
LNAGE	Log of age		.062	-.119
			(1.36)	(-1.37)
CHILD	Child		-.167	-.419
			(-1.82)	(-2.90)
FAD1	Indicates female aged 18-39		-.071	-.239
			(-1.34)	(-2.35)
FAD2	Indicates female aged ≥ 40		-.011	.024
			(-0.21)	(0.45)
ADULT2	Age ≥ 40			
LNINC	Log of 75-76 income, min = 1000		-.028	.025
			(-0.98)	(0.58)
LFAM	Log of family size		.026	.052
			(0.56)	(0.75)
TWOHEAD	Two heads in HHLD		-.034	-.019
			(-0.68)	(-0.22)
AFDC	AFDC family		.027	.028
			(0.39)	(0.28)
MISINC	Income missing		.149	.177
			(1.68)	(1.76)
MISAFDC	AFDC missing		-.111	-.275
			(-1.09)	(-1.88)
BLACK	Black indicator		.075	-.063
			(1.06)	(-0.68)

Table 10.2--continued

Variables, X	Definitions	(1)	(2)	(3)
GHINDX	General Health Index: actual: non-Dayton		-.0009 (-0.88)	-.004 (-1.98)
GHINMIS	Indicates GHINDX is missing		.048 (0.21)	-.637 (-1.75)
FORM1	Infant health form		-.0031 (-0.02)	.070 (0.28)
FORM2	Pediatric health form		-.055 (-0.59)	-.060 (-0.50)
GHI_GHMS	GHINMIS * GHINDX		.0001 (0.05)	.005 (1.27)
P25	Indicates coinsurance rate 25%		-.012 (-0.28)	.025 (0.40)
P50	Indicates coinsurance rate 50%		-.018 (-0.31)	-.024 (-0.23)
P95	Indicates coinsurance rate 95%		-.111 (-2.13)	-.108 (-1.38)
IDP	Indicates Individual Deductible plan		-.024 (-0.59)	-.035 (-0.47)

Table 10.3

LOG COST PER VISIT FOR "TARGETED" NONPREVENTIVE OUTPATIENT MEDICAL CARE: PARAMETER ESTIMATES
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)	(3)
CONSTANT	Constant	2.276 (44.66)	3.072 (5.16)	2.99 (4.94)
YEAR 2	Year 2 of study	-.039 (-0.36)	-.008 (-0.10)	-.009 (-.011)
YEAR 3	Year 3 of study	.058 (0.84)	.041 (0.73)	.038 (0.65)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	-.066 (-0.98)	-.062 (-0.94)	-.055 (-0.82)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	.069 (0.68)	.042 (0.49)	.065 (0.71)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	-.0009 (-0.01)	.015 (0.19)	.018 (0.22)
P1-PBAR	(Prev. visits Year 1 minus PBAR) * YEAR2	.010 (1.46)	.076 (1.44)	
P2-PBAR	(Prev. visits Year 2 minus PBAR) * YEAR3	.041 (1.00)	.046 (1.09)	
PBAR	Annual average number of preventive visits	-.071 (-1.56)	-.073 (-1.69)	
SEATTLE	Dummy indicating Seattle, Wash.		-.222 (-0.87)	-.220 (-0.87)
FITCHBURG	Dummy indicating Fitchburg, Mass.		-.208 (-0.81)	-.199 (-0.78)
FRANKLIN	Dummy indicating Franklin, Mass.		-.125 (-0.50)	(-.125) (-0.50)
WKLYHR	Weekly HLTH report type		-.0002 (-0.00)	-.004 (-0.06)
NOHR	HLTH Report Type is zero		-.134 (-1.66)	-.127 (-1.54)

Table 10.3--continued

Variables, X	Definitions	(1)	(2)	(3)
TERM3	Offered 3-year enrollment			
AGE	Age at enrollment		.002 (0.50)	.001 (0.26)
LNAGE	Log of age		-.136 (-1.57)	-.119 (-1.37)
CHILD	Child		-.405 (-2.96)	-.419 (-2.90)
FAD1	Indicates female aged 18-39		-.210 (-2.13)	-.239 (-2.35)
FAD2	Indicates female aged ≥ 40		.033 (0.63)	.024 (0.45)
ADULT2	Age ≥ 40			
LNINC	Log of 75-76 income, min = 1000		.027 (0.63)	.025 (0.58)
LFAM	Log of family size		.042 (0.62)	.052 (0.75)
TWOHEAD	Two heads in HHLD		-.036 (-0.42)	-.019 (-0.22)
AFDC	AFDC family		.043 (0.42)	.028 (0.28)
MISINC	Income missing		.166 (1.70)	.177 (1.76)
MISAFDC	AFDC missing		-.275 (-1.93)	-.275 (-1.88)
BLACK	Black indicator		-.073 (-0.78)	-.063 (-0.68)

Table 10.3--continued

Variables, X	Definitions	(1)	(2)	(3)
GHINDX	General Health Index: actual: non-Dayton		-.004 (-2.07)	-.004 (-1.98)
GHINMIS	Indicates GHINDX is missing		-.673 (-1.84)	-.637 (-1.75)
FORM1	Infant health form		.064 (0.26)	.070 (0.28)
FORM2	Pediatric health form		-.064 (-0.54)	-.060 (-0.50)
GHI_GHMS	GHINMIS * GHINDX		.006 (1.36)	.005 (1.27)
P25	Indicates coinsurance rate 25%		.018 (0.28)	.025 (0.40)
P50	Indicates coinsurance rate 50%		-.037 (-0.36)	-.024 (-0.23)
P95	Indicates coinsurance rate 95%		-.109 (-1.47)	-.108 (-1.38)
IDP	Indicates Individual Deductible plan		-.036 (-0.50)	-.035 (-0.47)

Table 10.4

LOG COST PER VISIT FOR INPATIENT MEDICAL CARE:
PARAMETER ESTIMATES
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)	(3)
CONSTANT	Constant	6.382 (100.3)	5.498 (11.32)	5.56 (11.33)
YEAR 2	Year 2 of study	.051 (0.39)	.056 (0.49)	.054 (0.48)
YEAR 3	Year 3 of study	.132 (1.27)	.109 (1.18)	.127 (1.38)
TOOKPHY1	(Took physical exam at enrollment) * Year 1	-.106 (-1.27)	-.111 (-1.47)	-.112 (-1.50)
TOOKPHY2	(Took physical exam at enrollment) * Year 2	-.075 (-0.56)	-.056 (-0.50)	-.055 (-0.49)
TOOKPHY3	(Took physical exam at enrollment) * Year 3	-.103 (-0.93)	-.146 (-1.57)	-.164 (-1.75)
P1-PBAR	(Prev. visits Year 1 minus PBAR) * YEAR2	-.041 (-0.49)	-.005 (-0.08)	
P2-PBAR	(Prev. visits Year 2 minus PBAR) * YEAR3	-.068 (-0.90)	(-.133 (-2.16)	
PBAR	Annual average number of preventive visits	-.031 (-0.54)	.017 (0.34)	
SEATTLE	Dummy indicating Seattle, Wash.		-.333 (-1.45)	-.334 (-1.44)
FITCHBURG	Dummy indicating Fitchburg, Mass.		-.097 (-0.40)	-.098 (-0.40)
FRANKLIN	Dummy indicating Franklin, Mass.		-.397 (-1.70)	-.402 (-1.71)
WKLYHR	Weekly HLTH report type		-.075 (-0.78)	-.065 (-0.68)
NOHR	HLTH report type is zero		.070 (0.84)	.080 (0.96)

Table 10.4--continued

Variables, X	Definitions	(1)	(2)	(3)
TERM3	Offered 3-year enrollment			
AGE	Age at enrollment		.008 (2.26)	.009 (2.40)
LNAGE	Log of age		.095 (1.59)	.082 (1.35)
CHILD	Child		-.247 (-1.55)	-.235 (-1.47)
FAD1	Indicates female aged 18-39		.0008 (-0.01)	-.0005 (-0.01)
FAD2	Indicates female aged ≥ 40		.075 (0.81)	.067 (0.79)
ADULT2	Age ≥ 40			
LNINC	Log of 75-76 income, min = 1000		.048 (1.19)	.044 (1.07)
LFAM	Log of family size		.061 0.80	.066 (0.88)
TWOHEAD	Two heads in HHLD		-.011 (-0.12)	-.015 (-0.16)
AFDC	AFDC family		.123 (1.16)	.123 (1.18)
MISINC	Income missing		.024 (0.17)	.015 (0.11)
MISAFDC	AFDC missing		-.151 (-0.80)	-.149 (-0.81)
BLACK	Black indicator		.183 (1.72)	.184 (1.71)

Table 10.4--continued

Variables, X	Definitions	(1)	(2)	(3)
GHINDX	General Health Index: actual: non-Dayton		.001 (0.52)	.0001 (0.53)
GHINMIS	Indicates GHINDX is missing		.307 (0.59)	.299 (0.58)
FORM1	Infant health form		.143 (0.72)	.129 (0.64)
FORM2	Pediatric health form		.131 (0.83)	.123 (0.80)
GHI_GHMS	GHINMIS * GHINDX		-.006 (-0.99)	-.006 (-0.99)
P25	Indicates coinsurance rate 25%		.179 (2.13)	.186 (2.22)
P50	Indicates coinsurance rate 50%		-.199 (-1.87)	-.188 (-1.78)
P95	Indicates coinsurance rate 95%		-.087 (-1.21)	-.074 (-1.02)
IDP	Indicates Individual Deductible plan		-.052 (-0.65)	-.042 (-0.53)

XI. ESTIMATES OF MODELS FOR CHANGES IN HEALTH STATUS

This section presents a complete set of estimates for the equation for changes in health status. Each includes both the relatively simple ANOVA specification and an ANACOVA specification including demographic variables, cost-sharing covariates, and the preventive variables. These estimates appear in Table 11.1.

Table 11.1

CHANGE IN GENERAL HEALTH INDEX PARAMETER ESTIMATES
(t-Statistics in parentheses)

Variables, X	Definitions	(1)	(2)
CONSTANT	Constant	1.552 (.22)	1.632 (.24)
SEATTLE	Dummy indicating Seattle, Wash.	-.723 (.26)	-.729 (.26)
FITCHBURG	Dummy indicating Fitchburg, Mass.	-3.090 (-1.12)	-3.122 (-1.13)
FRANKLIN	Dummy indicating Franklin, Mass.	-1.908 (-.70)	-1.937 (-.71)
WKLYHR	Weekly Health report type	-.437 (-.39)	-.435 (-.39)
NOHR	Health report type is zero	2.190 (2.03)	2.186 (2.02)
TERM3	Offered 3-year enrollment	-.844 (-1.35)	-.838 (-1.34)
AGE	Age at enrollment	-.159 (-2.45)	-.159 (2.45)
LNAGE	Log of age	2.188 (1.48)	2.190 (1.48)
CHILD	Child	.066 (.05)	-.010 (-.01)
FCHILD	Indicates female aged < 18	-.769 (-.95)	-.769 (-.95)
FAD1	Indicates female aged 18-39	.676 (1.01)	.561 (0.76)
FAD2	Indicates female aged ≥ 40	-.226	-.330
ADULT2	Indicates adult aged ≥ 40	.087 (.07)	.083 (.07)

Table 11.1--continued

Variables, X	Definitions	(1)	(2)
LNINC	Log of 75-76 income, min = 1000	-.327 (-.61)	-.344 (-.64)
LFAM	Log of family size	-.826 (-1.23)	-.815 (-1.21)
TWOHEAD	Two heads in HHLD	.047 (.05)	.043 (.05)
AFDC	AFDC family	.642 (.42)	.633 (.42)
MISINC	75-76 income missing	-2.486 (-1.08)	-2.484 (-1.08)
MISAFDC	AFDC missing	1.215 (.49)	1.231 (.50)
BLACK	Black indicator	3.456 (2.70)	3.488 (2.73)
GHINMIS	Indicates GHINDX is missing	-3.650 (-1.41)	-3.666 (-1.42)
FORM1	Infant health form	2.736 (.68)	2.682 (.67)
FORM12	Changed from infant to pediatric form	.908 (.34)	.921 (.35)
FORM2	Pediatric health form	1.551 (1.16)	1.552 (1.16)
FORM23	Changed from pediatric to adult form	-8.066 (-6.01)	-8.078 (-6.02)

Table 11.1--continued

Variables, X	Definitions	(1)	(2)
P25	Indicates coinsurance rate 25%	-.064 (-.08)	-.057 (-.07)
P50	Indicates coinsurance rate 50%	.799 (.67)	.823 (.69)
P95	Indicates coinsurance rate 95%	.538 (.71)	.565 (.74)
IDP	Indicates Individual Deductible plan	-.194 (-.26)	-.166 (-.22)
TOOKPHYS	Indicates given physical exam at enrollment	.126 (.22)	.120 (.21)
HADPREV	Indicates had preventive care during study	-- --	.221 (.39)

Appendix A

ESTIMATES OF MODELS FOR VISIT COUNTS WITH COVARIATES AFFECTING THE MIXING DISTRIBUTION

This appendix reports estimates of the parameters of the preventive outpatient visit count models, where demographic variables enter the regression equation for the mean of the ordered probit normal variate. Because these covariates were jointly insignificant for the inpatient admission-count models, they are not reported.

Table A.1

OUTPATIENT AND PREVENTIVE VISIT COUNTS: PARAMETER ESTIMATES INCLUDING COVARIATE EFFECTS ON HETEROGENEITY MIXTURE WITH PERIOD EFFECTS

		Outpatient		
Variables, Z	Definitions	All Visits	Targeted Visits	Preventive Visits
CONSTANT, β_o	Constant	.659 (13.49)	.627 (-6.72)	4.10 (73.77)
YEAR2	Year 2 of study	-.048 (-1.28)	-.043 (-.561)	-.275 (-4.15)
YEAR3	Year 3 of study	-.148 (-4.28)	-.029 (-.428)	-.295 (-4.61)
TOOKPHYS1	(Took physical exam at enrollment) * Year 1	.094 (1.66)	.200 (2.25)	-.081 (-1.38)
TOOKPHYS2	(Took physical exam at enrollment) * Year 2	.035 (.612)	.003 (.029)	.057 (.913)
TOOKPHYS3	(Took physical exam at enrollment) * Year 3	.714 (3.00)	.104 (1.10)	.110 (1.74)
P1-PBAR	(Prev. visits Year 1 minus PBAR) * YEAR2	.058 (.550)	.283 (.754)	
P2-PBAR	(Prev. visits Year 2 minus PBAR) * YEAR3	-.045 (-.462)	.142 (.372)	
PBAR	Annual average number of preventive visits	.290 (3.61)	.222 (2.10)	
SEATTLE	Seattle, Wash.	-.022 (-.084)	-.239 (-.435)	-.580 (-3.13)
FITCHBURG	Dummy indicating Fitchburg, Mass.	-.324 (-1.20)	-1.03 (-1.84)	-.433 (-2.36)
FRANKLIN	Dummy indicating Franklin, Mass.	-.436 (-1.64)	-1.17 (-2.14)	-.301 (-1.64)
WKLYHR	Weekly HLTH report type	-.104 (-1.33)	-.149 (-1.27)	.031 (.402)
NOHR	HLTH report type is zero	.095 (1.05)	.644 (3.55)	.021 (.301)

Table A.1--continued

Variables, Z	Definitions	Outpatient All Visits	Outpatient Targeted Visits	Preventive Visits
TERM3	Offered 3-year enrollment	.034 .656	-.065 (-.854)	.040 (.878)
AGE	Age at enrollment	.011 (2.25)	.047 (5.60)	.019 (3.91)
LNAGE	Log of age	-.125 (-1.91)	-.384 (-2.32)	-.440 (-10.49)
CHILD	Child	.314 (2.45)	.400 (1.30)	.502 (2.70)
FAD1	Indicates female aged 18-39	.328 (4.22)	.544 (3.50)	.802 (5.27)
FAD2	Indicates female aged ≥ 40	-.062 (-.684)	.600 (6.23)	.286 (1.93)
ADULT2	Age ≥ 40	.136 (.982)	-.239 (-1.08)	.456 (1.97)
LNINC	Log of 75-76 income, min = 1000	.048 (1.07)	.236 (3.11)	.093 (2.01)
LFAM	Log of family size	-.022 (-.334)	-.342 (-3.51)	-.181 (-3.06)
TWOHEAD	Two heads in HHLD	-.099 (1.14)	.192 (1.38)	.005 (.071)
AFDC	AFDC family	-.075 (-.757)	.444 (2.30)	.009 (.095)
MISINC	75-76 income missing	-.211 (-1.26)	-.063 (-.291)	-.269 (-1.90)
MISAFDC	AFDC missing	-.153 (-.759)	-.295 (-.902)	-.034 (-.177)
BLACK	Black indicator	-.909 (-7.35)	-.375 (-2.18)	.069 (.491)
GHINDX	General Health Index: actual: non-Dayton	-.009 (-5.43)	-.013 (-4.91)	-.007 (-.904)

Table A.1--continued

Variables, Z	Definitions	Outpatient		
		All Visits	Targeted Visits	Preventive Visits
GHINMIS	Indicates GHINDX is missing	.759 (1.82)	.636 (.903)	-.594 (-.233)
FORM1	Infant health form	-.038 (-.219)	-.337 (-.659)	-.199 (-1.45)
FORM2	Pediatric health form	-.240 (-2.09)	-.145 (-.467)	-.121 (-1.13)
GHI_GHMS	GHINMIS * GHINDX	-.009 (-1.94)	-.014 (-2.13)	.021 (.296)
P25	Indicates coinsurance rate 25%	.012 (.193)	-.158 (-1.71)	-.061 (-1.33)
P50	Indicates coinsurance rate 50%	-.297 (-3.27)	-.419 (-2.46)	-.144 (-2.16)
P95	Indicates coinsurance rate 95%	-.202 (-2.86)	-.310 (-3.00)	-.300 (-6.20)
IDP	Individual Deductible plan	-.335 (-4.80)	-.455 (-3.90)	-.303 (-6.32)
GHI2	Square of GHINDX			.00006 (1.01)
GH2_GHM2	GHI2 * GHINMIS			-.0002 (-.429)

Table A.2

OUTPATIENT AND PREVENTIVE VISIT COUNTS: PARAMETER ESTIMATES INCLUDING COVARIATE EFFECTS ON HETEROGENEITY MIXTURE WITHOUT PERIOD EFFECTS

		Outpatient		
Variables, Z	Definitions	All Visits	Targeted Visits	Preventive Visits
CONSTANT, β_o	Constant	1.10 (13.48)	-.581 (-7.10)	.582 (-7.33)
TOOKPHYS		-.098 (-1.27)	-.105 (-1.17)	
PBAR	Annual average number of preventive visits	.249 (1.86)	.270 (1.77)	
SEATTLE	Seattle, Wash.	-.293 (-.627)	.131 (.200)	1.08 (2.07)
FITCHBURG	Dummy indicating Fitchburg, Mass.	-.090 (-.191)	.343 (.521)	1.57 (2.92)
FRANKLIN	Dummy indicating Franklin, Mass.	-.096 (-.207)	.305 (.466)	1.33 (2.56)
WKLYHR	Weekly HLTH report type	.146 (1.24)	.370 (2.61)	.002 (.001)
NOHR	HLTH report type is zero	-.090 (-.661)	-.660 (-2.92)	.017 (.080)
TERM3	Offered 3-year enrollment	-.021 (-.266)	.178 (1.89)	-.145 (-1.16)
AGE	Age at enrollment	.003 (.333)	.0003 (.027)	-.028 (-2.13)
LNAGE	Log of age	-.011 (-.096)	.372 (1.15)	.511 (3.13)
CHILD	Child	.048 (.249)	-.048 (-.134)	1.10 (3.24)
FAD1	Indicates female aged 18-39	.205 (1.77)	.229 (1.33)	1.90 (6.96)

Table A.2--continued

Variables, Z	Definitions	Outpatient All Visits	Outpatient Targeted Visits	Outpatient Preventive Visits
FAD2	Indicates female aged ≥ 40	.509 (3.71)	-.462 (-3.61)	1.60 (6.46)
ADULT2	Age ≥ 40	-.124 (-.608)	.486 (1.92)	-.054 (-.145)
LNINC	Log of 75-76 income, min = 1000	.124 (1.77)	-.890 (-.936)	.274 (2.54)
LFAM	Log of family size	-.242 (-2.48)	.187 (1.55)	-.100 (-.624)
TWOHEAD	Two heads in HHLD	.342 (2.62)	-.281 (-.164)	.162 (.821)
AFDC	AFDC family	.296 (1.99)	-.492 (-2.04)	.312 (1.23)
MISINC	75-76 income missing	.194 (.709)	.107 (.382)	.515 (1.41)
MISAFDC	AFDC missing	.069 (.222)	.274 (.684)	-.632 (-1.27)
BLACK	Black indicator	.559 (2.75)	.351 (1.60)	-.614 (-2.36)
GHINDX	General Health Index: actual: non-Dayton	.006 (-2.14)	-.011 (-2.99)	-.047 (-1.30)
GHINMIS	Indicates GHINDX is missing	-.128 (-.178)	.303 (.332)	-2.26 (-.461)
FORM1	Infant health form	.266 (1.01)	.136 (.187)	1.66 (3.13)
FORM2	Pediatric health form	.302 (1.76)	-.235 (-.646)	.140 (.509)
GHI_GHMS	GHINMIS * GHINDX	-.003 (-.370)	.00003 (.003)	.067 (.478)

Table A.2--continued

Variables, Z	Definitions	Outpatient		
		All Vsits	Targeted Visits	Preventive Visits
P25	Indicates coinsurance rate 25%	-.339 (-3.51)	-.025 (-.215)	
P50	Indicates coinsurance rate 50%	-.189 (-1.31)	.056 (.279)	
P95	Indicates coinsurance rate 95%	-.453 (-4.49)	-.163 (-1.28)	
IDP	Individual Deductible plan	-.051 (-.481)	.164 (1.18)	
GHI2	Square of GHINDX			.0003 (1.25)
GH2_GHMS	GHI2 * GHINMIS			-.0003 (-.342)

Appendix B

THE HIE MEDICAL SCREENING EXAMINATION

The Health Insurance Experiment medical screening examination differs from screening programs in general; its primary purpose was to assess physiologic health on the basis of data that would not be recollected or supplemented with further testing. For that reason, both specificity and sensitivity were considered when tests were selected for the screening examination. The data collected during the medical screening examination are used as a measure of physiologic health; they indicate whether certain body organ systems are functioning at a level expected for the individual. Multiphasic screening was selected as the method for collecting data on physiologic health because it allows testing methods to be standardized. It uses nonphysician personnel who administer, in a carefully specified manner, a series of tests. Table B.1 summarizes the diseases or conditions to be identified by the screening examination, the technique used in the examination, the population screened for each test, and the MHQ questions that pertain to each disease or condition.

Table B.1

PHYSIOLOGIC HEALTH DISEASES/CONDITIONS: AN OUTLINE OF THEIR MEASUREMENT STRATEGY

Disease Condition	Screening Test	Population Screened	Medical History Questionnaire Abbreviated Content
Acne	Facial Skin Photograph	All persons ≥ 14 years of age who either claim to have acne, or appear to have acne	Trouble with pimples? Doctor said had acne? Saw doctor about pimples? Doctor prescribed x-ray? Doctor prescribed ultra violet light? Doctor prescribed special soap? Doctor prescribed special diet? Doctor prescribed popping pimples? Doctor prescribed medicines? Currently using x-ray? Currently using ultra violet? Currently using special soap? Currently popping pimples? Currently using other medicines?
Alcoholism and Liver Disease	Blood Alcohol Level Total Bilirubin SGOT	All persons ≥ 14 years of age	Ever had at least one drink? During 12 months when drinking most, how often did you drink? During past 12 months, how often did you drink? Quantity Index (total quantity of ethanol consumed in a typical drinking day) Quantity-Frequency Index (average quantity of ethanol consumed in one day) Doctor said cirrhosis of the liver? Drinking worried you, past 3 months? Drinking restricted activities past 3 months? Days in bed due to drinking in past month? Doctor ever said cut down? Doctor ever said cut down for D.T.'s? Currently doing any of these to cut down: Alcoholics Anonymous, Counselor, Social Worker, Doctor, Psychologist, Psychiatrist? Been in accident after drinking?
Anemia	Hematocrit Hemoglobin Mean Corpuscular Volume	All persons ≥ 6 months of age	Doctor said you currently have anemia and you are under treatment? Iron pills or shots prescribed in last year? Currently taking treatments for anemia? Last time you saw a doctor for anemia?
Cardiovascular Disease 1) Angina Pectoris/ Ischemic Heart Disease	1) Electrocardiogram	1) All persons ≥ 25 years of age (except pregnant women) and persons ≥ 14 years of age answering positively to questions regarding the presence of heart or lung disease, or if blood pressure reading is ≥ 140/90, or if there is a history of hypertension	1) Have you had pain, discomfort, heaviness, or pressure in your chest in past 12 months? Get chest pain when walking uphill or hurry? Get chest pain when walking at ordinary pace on level ground? Response to chest pain when walking? If stand still what happens to chest pain? Take nitroglycerin if get chest pain when walking? Location of chest pain: Upper middle chest, lower chest, left chest, right chest, left arm, somewhere else? Has a doctor ever said you had a heart attack?
2) Congestive Heart Failure	2) Chest X-ray	2) Men ≥ 30, women ≥ 35 and persons ≥ 14 with blood pressure ≥ 140/90 or giving a history of hypertension, or answer positively to heart disease questions	2) Felt short of breath, doctor said heart failure? Wake at night short of breath, must sit up for relief? Doctor said weak heart or heart failure? Ankles swell, make shoes tight? Ankles still swollen next morning? Sleep on more than one pillow because of short breath? Currently taking prescribed diuretic pills? Currently taking heart medicines?
3) Hypercholesterolemia	3) Serum Cholesterol Level	3) All persons ≥ 14 years of age	3) Ever had cholesterol test? Doctor ever said have high cholesterol? Last time you saw doctor about high cholesterol? Doctor ever prescribed medicine? Currently taking medicine? Think your cholesterol high, normal, low?

Table B.1--continued

Disease Condition	Screening Test	Population Screened	Medical History Questionnaire Abbreviated Content
Abnormal Child Growth and Development	1) a. Head Circumference b. Length c. Height d. Weight 2) Denver Developmental Screening Examination	1) a. Children ≤ 2 years of age b. Children ≤ 2 years of age c. Children ≥ 2 years of age d. ≥ 3 months up to < 5 years 2) ≥ 3 months up to < 5 years	1) What weight at birth? How tall now? What weight now? 2) Born prematurely? Age first rolled over? Age first sat up? Age first walked? Age spoke first word? Parent satisfied with child's development?
Dental Disorders 1) Hard Tissue (Tooth) Disease 2) Periodontal Disease	1) a. Decayed-Missing-Filled Index b. Gross Decay Index c. Simplified Oral Hygiene Index 2) Periodontal Index	1) a. All persons 3 years or older b. All persons 3 years or older c. All persons 3 years or older 2) Persons 14 years or older[a]	Have any natural teeth? Dentist said you have gum problems? Dentist said gum problems cause early tooth loss? Dental Health Habit (questions asked verbally during screening examination)
Diabetes	2-hour Post-load Glucose[b]	All persons ≥14 years of age except diabetics taking insulin or oral agents[c]	Think you have diabetes or prediabetes? Doctor or nurse say had diabetes or pre-diabetes? Take insulin? Take medicine for diabetes by mouth? Has a doctor or nurse told you to check urine for sugar?
Drug Usage	Urine Drug Screen	All persons ≥ 14 years of age	Doctor prescribed sleeping pills? Currently using sleeping pills? Doctor prescribed tranquilizers, sedatives? Currently using tranquilizers, sedatives?
Glaucoma	Tonometry	All persons ≥ 40 years of age	In the past 5 years, have you had your eyes checked for glaucoma? Doctor said have glaucoma? Last time saw a doctor for glaucoma? Doctor prescribed medicine for glaucoma? Currently taking eye drops for glaucoma? Currently taking pills for glaucoma?
Syphilis and Gonorrhea	None	----	Syphilis Doctor ever said have syphilis? Drugs prescribed or injection for syphilis? Gonorrhea, Clap, VD Had gonorrhea, clap, VD in past year?
Hay Fever	None	----	Ever had hay fever? Last time you saw a doctor for hay fever? Get shots to help prevent hay fever? Doctor prescribed any medicine to help prevent symptoms of hay fever? Actually take medicine for hay fever?
Hearing Disorders	1) Pure-Tone Threshold Audiometry 2) Tympanometry	1) All persons ≥ 4 years of age 2) All persons ≥ 4 years of age except those who have had ear surgery in the past 6 months[d]	Describe hearing in the left ear. Describe hearing in the right ear. Do you wear a hearing aid? Trouble hearing without a hearing aid?

[a]Persons 12 years of age or older on exit screening examination.

[b]No glucose load administered on exit screening examination; casual glucose level measured instead.

[c]All persons ≥ 14 years of age on exit screening examination.

[d]Tympanometry on ages 4 through 13 on exit screening examination.

Table B.1--continued

Disease Condition	Screening Test	Population Screened	Medical History Questionnaire Abbreviated Content
Hemorrhoids	None	----	Had hemorrhoids in the past year? Ever seen a doctor for hemorrhoids? Doctor prescribed rectal suppositories for hemorrhoids? Doctor prescribed sitzbaths for hemorrhoids? Taken rectal suppositories for hemorrhoids? Used sitzbaths for hemorrhoids?
Hernia	None	----	Had hernia in past 12 months? Ever had operation for hernia? Last time saw doctor for hernia? Scheduled for operation for hernia?
Hypertension	Sitting Blood Pressure--repeat B.P. if first reading $\geq$ 140/90 Standing B.P. if screenee on antihypertensive medications	All persons $\geq$ 14 years of age	Ever told by doctor had high blood pressure? Told blood pressure high more than once? Doctor prescribed medication for high blood pressure? Currently taking medication for high blood pressure? Blood pressure currently high or normal?
Joint Problems (Osteoarthritis Rheumatoid Arthritis)	1) 50-Foot Walk Grip Strength Joint Size Rheumatoid Factor 2) Hand-Wrist X-ray[e]	1) Persons $\geq$ 14 years of age claiming to have pain or swelling in their joints 2) Persons $\geq$ 14 years of age claiming to have pain in hands and/or wrists[e]	Pain, aching, swelling, stiffness in joints? Pain, aching on most days for one month? Swelling and pain for one month when touched? Stiffness for one month on getting up in morning? Stiffness lasting for at least 15 minutes on getting up? Doctor said rheumatism, arthritis? Last time saw doctor? Aspirin taken for joint problems? Can you perform activities of daily living (defined)? Number of aspirins taken for joint problems?
Gout	Uric Acid	All persons $\geq$ 14 years of age	Doctor said gout? Currently taking medication for gout, high uric acid?
Kidney Disease	1) BUN/creatinine 2) Dipstick Blood and Protein 3) Microscopic Urinalysis 4) Urine Culture	1) All persons $\geq$ 14 years 2) Females $\geq$ 6, males $\geq$ 14 3) Females $\geq$ 6, males $\geq$ 14[f] 4) Females $\geq$ 6 years	Doctor ever say had kidney disease? Ever had kidney, bladder, urine infection? Frequency of infection? Currently have kidney, bladder, urine infection? Currently take any medication? Last time you saw doctor for kidney, bladder, urine infection?
Lead Poisoning	Blood Lead Level	Persons 1 to 5 years of age	None
Missing Limbs	Observation for missing limbs[g] (Dayton only)	All persons	Do you have any missing limbs?
Obesity	Height Weight Computation of Body-Mass Index	All persons > 2 years of age	Overweight, based on respondent's opinion. On diet? Follow diet? Special exercises to lose weight?

[e]No hand-wrist x-ray on exit screening examination.

[f]Females $\geq$ 6 years old (no males) on exit screening examination.

[g]Observation in Dayton; questions in MHQ for other sites.

Table B.1--continued

Disease Condition	Screening Test	Population Screened	Medical History Questionnaire Abbreviated Content
Respiratory Problems Chronic Obstructive Pulmonary Disease	1) Spirometry 2) Chest X-ray	1) All persons ≥ 14 years of age 2) All persons ≥ 25 (except pregnant women) and all persons ≥ 14 with blood pressure ≥ 140/90, or history of hypertension, or answering positively to heart or lung questions	Short of breath when hurry or walk uphill? Short of breath when walk on level ground with friends? Had to stop when walk on level because short of breath, at own pace? Short of breath when bathing, dressing? Doctor said bronchitis, emphysema? Last time saw doctor for this problem? Under doctor's care for bronchitis, emphysema? Any phlegm from chest in morning? Time of year most phlegm? Color of phlegm? Any phlegm other than morning? Phlegm most days for 3 months of year, last 2 years? How much phlegm? Currently bringing up phlegm? Doctor prescribed any of these treatments: Breathing exercise, postural drainage? Breathing machine? Avoid, decrease smoking? Get regular checkups? Get lots of rest? Decrease activity? Do you do any of these: Breathing exercises, postural drainage? Breathing machine? Avoid, decrease smoking? Get regular checkups? Decrease activity?
Tuberculosis	Chest X-ray	All persons ≥ 25 years of age (except pregnant women); and persons answering positively to tuberculosis questions	Doctor ever said had tuberculosis? Ever take prescribed medicine for TB? Last time you saw doctor for TB?
Smoking	None	----	Do you smoke cigars or pipe? Do you smoke cigarettes? How many years smoking? How much smoking? Doctor ever said to stop or cut down smoking? Have you ever smoked cigarettes regularly? How many years? How many packs smoked daily?
Thyroid Disease	1) Serum Thyroxine (T_4) 2) T_3 Uptake T_7	1) All persons ≥ 14 years of age 2) Pregnant women, women taking birth control pills, and persons taking thyroid medications	Doctor ever said had goiter or thyroid trouble? Doctor prescribed medicines for thyroid trouble? Doctor prescribed surgery for thyroid trouble? Doctor prescribed radiation for thyroid trouble? Currently taking medication for thyroid trouble? Last time you saw a doctor for thyroid or goiter?
Tonsil Disease	Tonsil Examination	Persons ≤ 19 years of age	Had tonsils removed?
Ulcer, Stomach Pain	Serum Pepsinogen[h] Blood Type[h] Saliva for Secretor Status[h] Urine Pepsinogen[h]	All persons ≥ 14 years of age	Trouble with stomach pain, ache? Had pain three days in one week? How soon after eating do attacks occur? Relieved by taking milk or food? Doctor said ulcer in stomach or duodenum? Ulcer confirmed? Currently taking antacids at least once a day?

[h]In cooperation with Center for Ulcer Research and Evaluation (CURE), UCLA, Los Angeles, California.

Table B.1--continued

Disease Condition	Screening Test	Population Screened	Medical History Questionnaire Abbreviated Content
Varicose veins	Varicose Vein Examination	All women ≥ 20 years of age, and men ≥ 14 who report having or having had varicose veins	Ever had surgery for varicose veins? Varicose veins in last year? Avoid wearing shorts in last year? Doctor said keep feet up during day? Doctor said wear support stockings? Currently keep feet up during day? Currently wear support stockings? Doctor recommend surgery for varicose veins?
Visual Disorders Refractive Problems	Near Vision[i] Far Vision[i] Pinhole Acuity Correction Motility[j]	All enrollees ≥ 3 years of age	Ever had eyesight tested by doctor? Last time eyes tested? Eye test needed for work, school, camp, insurance? Doctor prescribed glasses or contact lenses? Problems with seeing near: Wear glasses or contact lenses? Wear them for reading or close work? Without glasses, can you read newsprint? Problems with seeing far: Wear glasses or contact lenses? Wear them for seeing at a distance? Without glasses, can you recognize a friend across the street?
Stereopsis	TNO Stereoscopic Test[k]	All enrollees ≥ 3 ≤ 14 years of age	
Immunization Status	Serum antibody[k]	Persons 1 to 10 years of age	Received certain shots or immunizations?

[i]With and without glasses.

[j]No motility on exit screening examination.

[k]Exit screening examination only.

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